6

Chapter 6 - General Engineering and Environmental Aspects of the Arrowhead-Weston Project

This chapter is an introduction to a detailed analysis of the Arrowhead-Weston Transmission Project, including both the 345 kV line and the 115 kV line. It contains general information about the routes, line designs, and construction techniques proposed by the applicants. It also describes the field methods and forest fragmentation analysis methods used by Commission staff in its review of this project. Lastly, several of the project's environmental effects that are not route-specific, such as estimated magnetic fields, electric fields, and noise are discussed in this chapter.

The remainder of this document is organized as follows: Chapters 7-9 include a detailed analysis of each of the proposed routes and several additional routes developed by Commission staff, using route segments in the project application; Chapters 10-11 include the engineering and environmental analysis of the Tripoli to Rhinelander system alternatives and proposed routes; and Chapter 12 is a summary chapter that critically compares the routes within each sector and describes the major differences among the routes and between the Owen and Tripoli Sectors.

Descriptions and Maps of Each Route Sector

The following section describes the sectors and proposed routes of the 345 kV Arrowhead-Weston Transmission Project and the 115 kV transmission line from the new Tripoli Substation to the Highway 8 Substation in Rhinelander.

Arrowhead-Weston 345 kV line

The northernmost sector of the 345 kV line is the Oliver Sector. It is an approximately 10-mile wide corridor that extends from the St. Louis River, bordering northwestern Wisconsin and Minnesota, to a point just outside of the town of Exeland, north of Ladysmith. (See Figure 6-1.) Between Exeland and Wausau are two sectors, the Owen Sector and the Tripoli Sector.

The Owen Sector and the Tripoli Sector are two distinct corridors through which to route the 345 kV line to the Weston Substation. The Owen Sector continues in a southeasterly direction from Exeland to the Owen-Withee area. The corridor then turns east near STH 29 and extends east to Weston. (See Figure 6-3.) There are four alternate routes for the 345 kV line in the Owen Sector. The Tripoli Sector turns at Exeland and roughly parallels USH 8 to an area near the towns of Brantwood and Tripoli. In this general area the Tripoli Sector turns south and continues in a southerly/southeasterly direction to Weston. (See Figure 6-2.) There are four alternate routes for the 345 kV line in the Tripoli Sector.

If the applicants' 345 kV transmission line is approved, the routes in each of these three sectors can be independently considered in selecting an alignment for the 345 kV line between the St. Louis River, near Oliver, Wisconsin and the Weston Substation. One route would need to be chosen in the Oliver Sector and another route would need to be selected from either the Tripoli Sector or the Owen Sector. Any of the Oliver Routes could be joined to any of eight routes between Exeland and the Weston Substation. There is a "connector" segment that can be used to join the routes.

115 kV line for Rhinelander support

If the 345 kV line is approved and a route from the Tripoli Sector is selected, the Commission will decide whether to approve the construction of a new 345/115 kV substation near Tripoli and a new 42-mile long 115 kV transmission line to Rhinelander. There are four alternative substation sites; all are located in the vicinity of West Knox Road or CTH YY and USH 8.

The Rhinelander Sector, containing the possible routes for the 115 kV line between the new Tripoli Substation and Rhinelander, has been subdivided into two subsectors, a portion that lies west of USH 51 and a portion that lies east of USH 51. Each contains three alternate routes. In addition to the routes in the two subsectors, there are several "approach" segments (or combinations of segments) that could be used to exit any one of the four 345/115 kV substation sites and reach a common starting point for the three routes on the west side of USH 51. There are also several "connector" segments that parallel USH 51 and can be used to join any route on the west side of USH 51 with any of the three routes on the east side of USH 51 that proceed to the Highway-8 Substation. (See Figure 6-4.)

Approval of the 345 kV line project and of the 115 kV transmission line constitute two separate regulatory decisions, although the decision regarding the 115 kV line is linked to the approval of the 345 kV line. If the application to construct the 345 kV line was denied, construction of the 115 kV Tripoli to Rhinelander line would automatically be denied.

If the 345 kV Arrowhead-Weston Transmission Project is approved but a route from the Owen Sector is chosen to reach the Weston Substation, rather than a route from the Tripoli Sector, it would be necessary to consider meeting local load-serving needs in the Rhinelander area through another means. This could involve additional conservation and demand-side management programs, a new generation proposal, transmission line improvements, a new transmission line, or a combination of these means. Some of these alternative transmission solutions, several of which have been proposed by WPSC for supporting Rhinelander in previous Advance Plan proceedings, are described and discussed in Chapter 10.

Figure 6-1 The Oliver Sector

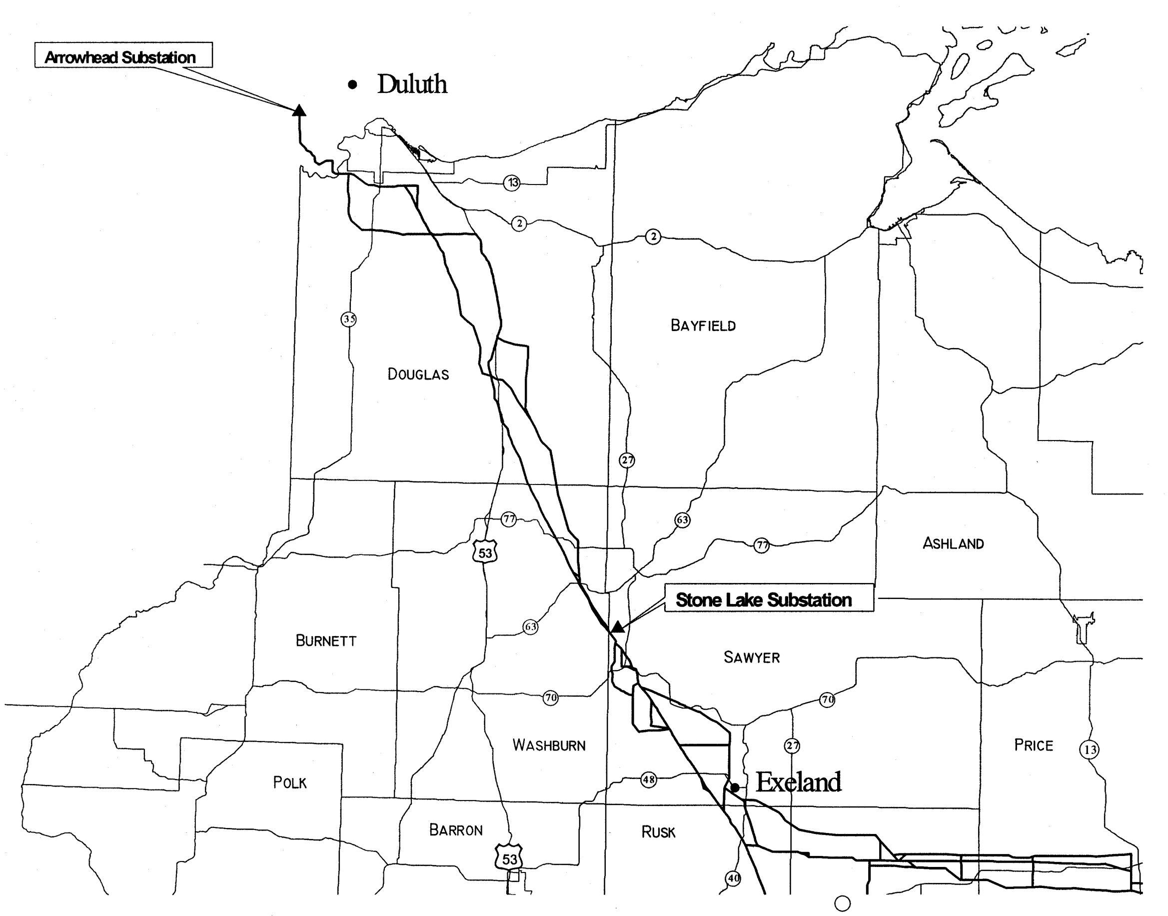


Figure 6-2 The Tripoli Sector

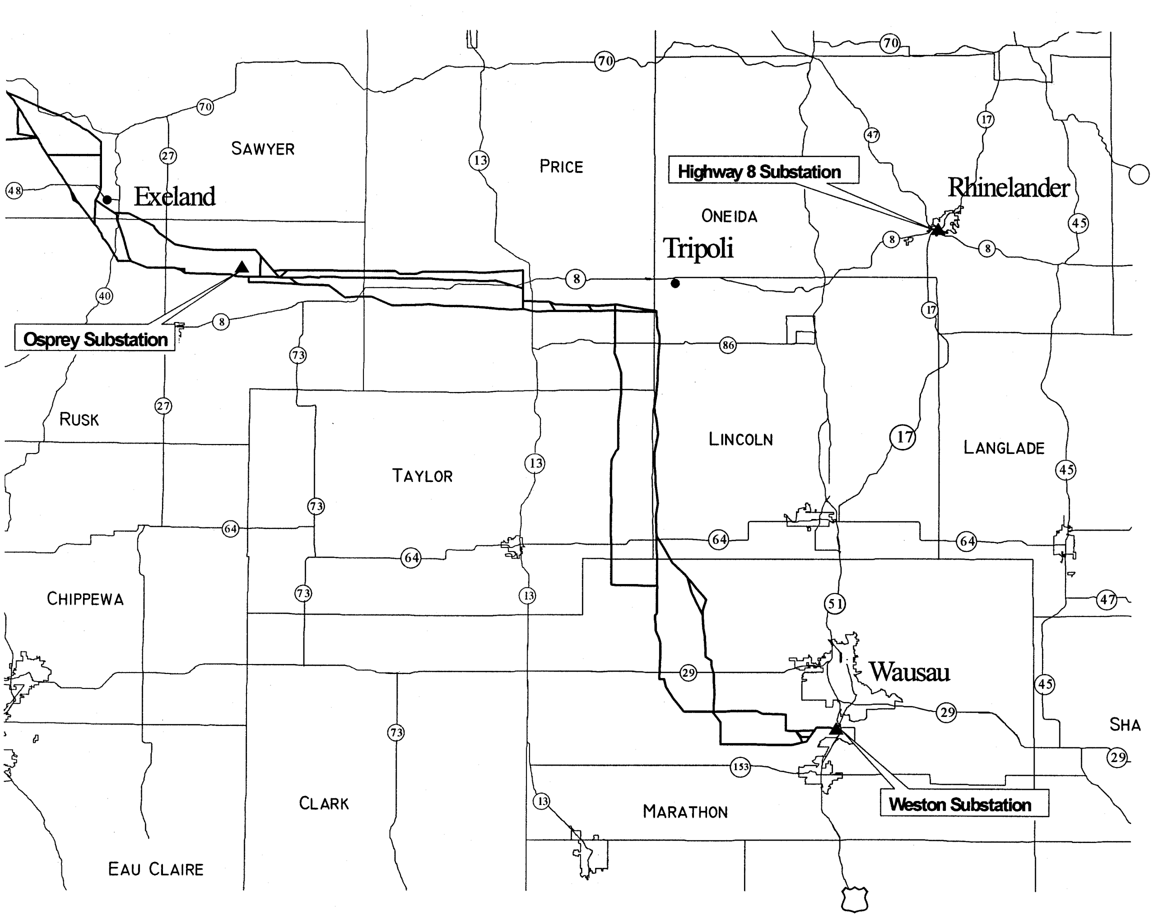


Figure 6-3 The Owen Sector

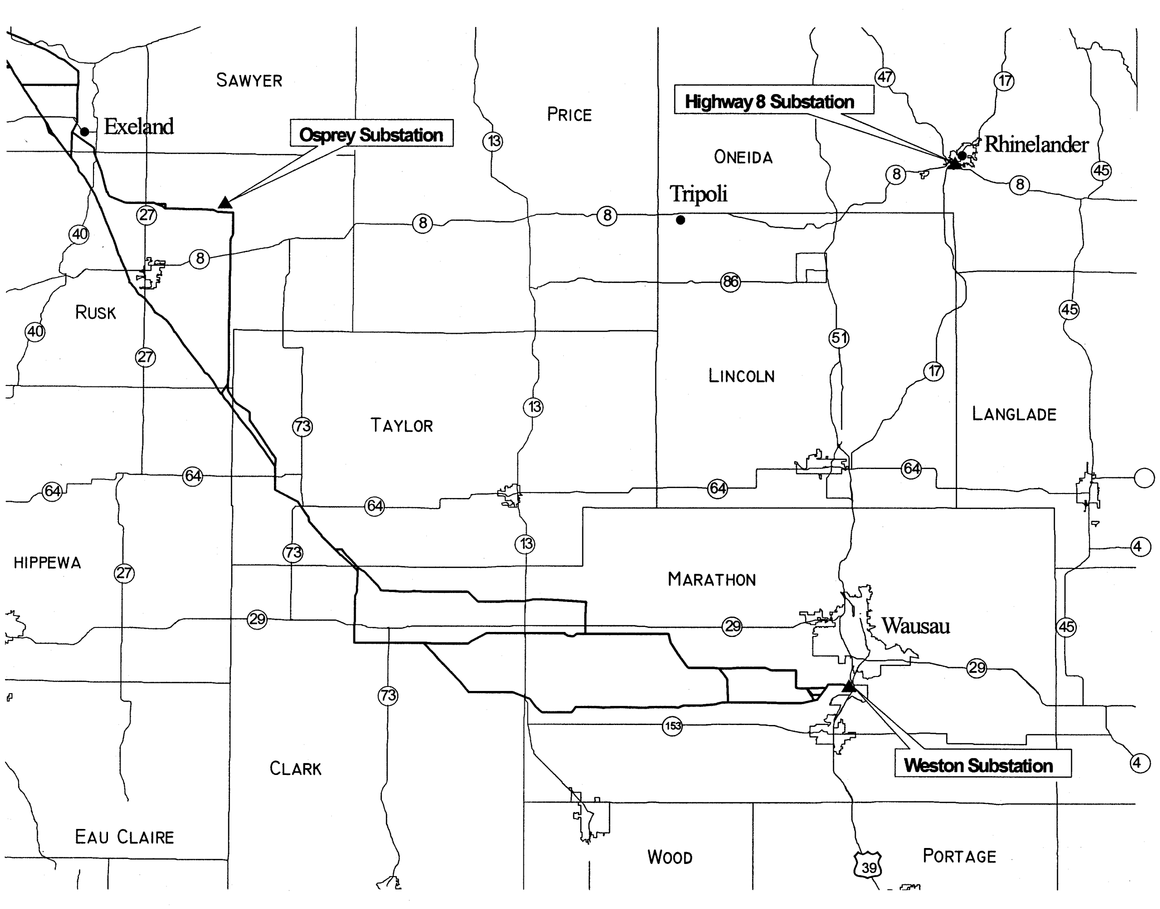
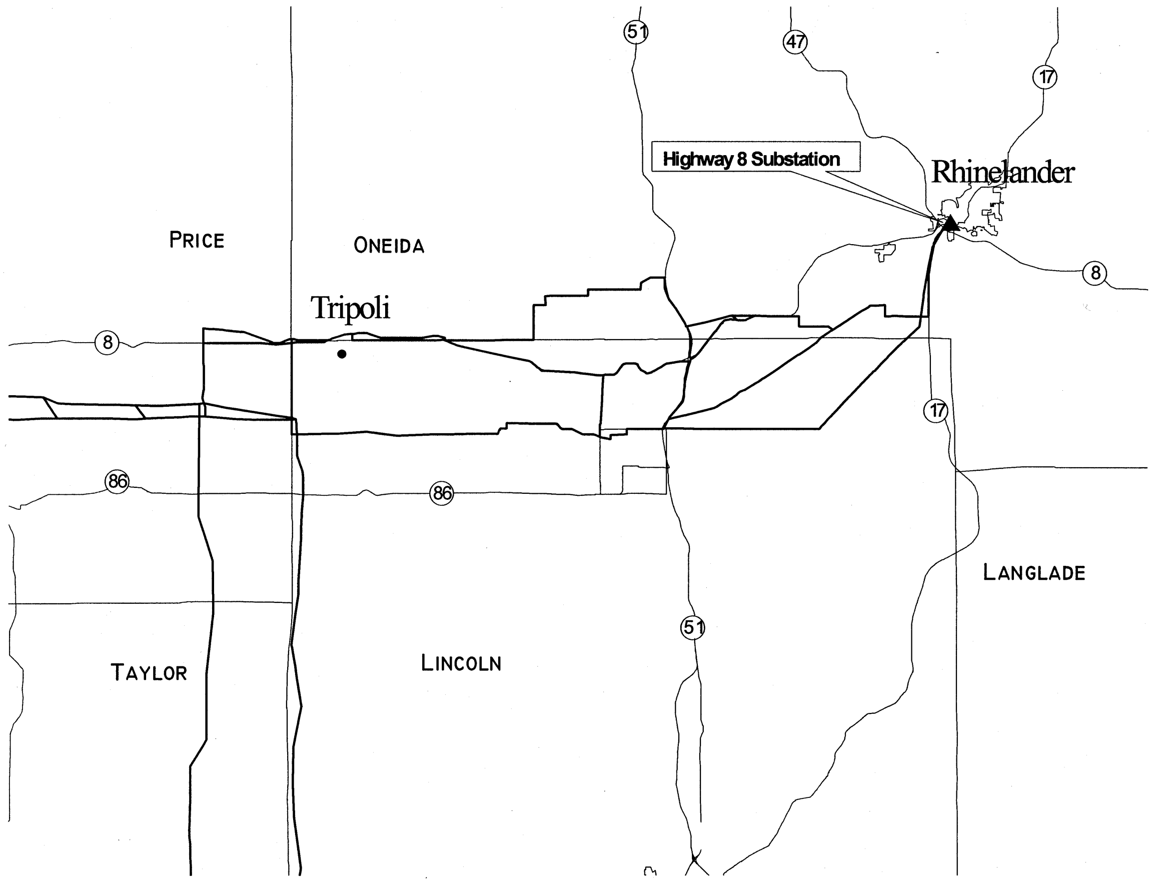


Figure 6-4 The Rhinelander Sector



General Route Descriptions and Engineering Characteristics of the Sectors

This section provides a brief description of the routes in each sector and some information about the segments that make up the routes. Also included is a discussion of the types of corridor sharing proposed for this project and structure diagrams (Figures 6-5 through 6-20) that show the proposed pole types and ROW dimensions in detail and in relation to other infrastructure corridors where the proposed routes are located.

Corridor sharing issues for the proposed project

The tables below and Chapters 7, 8, 9, and 11 provide information about what length and how much of the proposed routes are on or adjacent to corridors already occupied by other types of infrastructure (rail lines, pipelines, roads, and existing transmission lines). There are also detailed diagrams later in this chapter that illustrate possible ROW scenarios for adjacent infrastructure facilities. When two different types of infrastructure are located within or partially within the same ROW, or on ROWs directly adjacent to one another, it is often referred to as corridor sharing. The two uses may or may not actually be sharing the rights to some of the same land. Some of the different arrangements for sharing corridors and some of the advantages and disadvantages of corridor sharing are described below:

- High voltage transmission line poles are usually not located within the existing ROW of a pipeline, railroad, or road. The poles may be placed several feet outside of the existing ROW but the ROW of the new line could overlap the existing ROW to some extent. This "sharing" arrangement is possible when the existing easement owners are willing to allow the utility to purchase easement rights to a portion of the existing corridor.

  The amount of overlap allowed can vary depending on safety requirements or other factors. The width of the additional easement acquired for construction and maintenance of the 345 kV transmission line would be 120 feet (for single poles) or 150 feet (for H-frame) minus the amount of overlap allowed by the owner of the existing infrastructure. In the case of the proposed project, the applicants have indicated that parallel facilities with some ROW overlap would result in the need for 75-120 feet of additional ROW. In the case of the 115 kV Tripoli-Rhinelander transmission line, the additional easement needed would be 80 feet minus the amount of overlap allowed, or about 40-60 feet.

- Two (or sometimes three) separate ROW easements may be contiguous (directly adjacent to one another) but have no overlap. In this case, the appearance is that of a single wide corridor but the facilities are not using any of the same land. Some of the existing easement holders in the Arrowhead-Weston project area have stated a preference to not allow the applicants to overlap their ROWs due to concerns for safety or reliability of the existing infrastructure.[175] This preference would not preclude placing the line adjacent to the existing corridor but means that the amount of land needed for the new ROW would be wider than if there were overlap. For the proposed 345 kV line, the amount of ROW required would be 120 feet (for single poles) or 150 feet (for H-frames) unless otherwise determined. An 80-foot easement would be acquired for the 115 kV line unless otherwise determined.

Sometimes when the existing infrastructure and easement are located in a setting that is naturally clear of all woody vegetation or maintained in such a manner (e.g. pasture or crop land), the utility may, without pursuing an overlapping easement, locate the 345 kV transmission line in an adjacent corridor that is somewhat narrower than the 120 or 150 foot width proposed. This arrangement may also be necessary when the amount of available ROW is constrained in some manner. The applicants have stated that an easement of 100-132 feet for an H-frame structure and 75-108 feet for a single pole design may be adequate in those cases.

- Double circuiting a new transmission line with an existing transmission line generally provides the most corridor sharing. Double circuiting a 345 kV line with an existing transmission line (69, 115, 138, 161, 230, or 345 kV) would require 0-40 feet of new ROW, depending on the voltage of the line, the pole type and the width of the existing ROW. This is considerably less new ROW than other corridor sharing options.

NSPW and DPC are the major owners of existing power lines proposed for double circuiting in the project area. NSPW and DPC have stated that they are willing to agree to double circuit options approved by the Commission, provided that they are made whole and system reliability is not compromised.[176] This means that the applicants would pay for all construction and that the timing of any line outages during construction would be scheduled to minimize impact to NSPW and DPC customers and electric grid reliability.[177] [178]

The applicants have had some discussions with owners of some of the other existing facilities in the project area but no formal ROW sharing contracts/agreement have been finalized.

---

[175] Letter from Lakehead Pipe Line Company, Inc., dated October 27, 1999, to Neil Michek, Public Service Commission.

[176] NSPW maintains that they would want any lines rebuilt as part of the Arrowhead – Weston project to be built to 161 kV specifications.

[177] Application for the Arrowhead to Weston Transmission Project, Figure A32-1: letter dated August 9, 1999, from NSP addressed to Mr. Dave Valine of Wisconsin Public Service Corporation

[178] Applicants' response, dated August 8, 2000, to PSCW Data Request #10 regarding further negotiations with owners of existing infrastructure along the proposed transmission line routes.

The advantages of corridor sharing include the potential to require less new ROW and cause less new disturbance to the natural and human environment. Also, concentration of facilities in a single corridor would likely result in fewer and less serious aesthetic impacts.

However, placing a transmission line within or adjacent to an existing corridor may make it visible to a greater number of people if it is adjacent to a road or placed on taller structures required for double circuit designs. Safety concerns may exist, regarding collisions by cars or snowmobiles, and nearby pipelines could require cathodic protection from induced currents produced by the line. Also, landowners that have been affected by existing utility easements that limit the use of their land may be additionally burdened by another new facility. Some additional benefits and disadvantages of corridor sharing are covered in Chapter 5.

The Oliver Sector

There are three route options for the proposed 345 kV line in the Oliver Sector (Oliver to Exeland). Two of the routes were proposed by the utilities. They are described herein as the Oliver 1 and Oliver 2 Routes. In order to reduce potential environmental impacts and maximize corridor sharing, Commission staff has developed and analyzed a third route for Commission consideration, the Oliver 3 Route.

Oliver 1 Route

The Oliver 1 Route, which is 93.5 miles long, primarily follows existing corridors such as electric transmission lines, railroads, roads and gas or petroleum pipelines in a southeasterly direction from the St. Louis River to the area near Exeland. The only exception is the portion of the route that runs through and south of the LCO Reservation, where the applicants proposed use of new cross-country ROW in order to avoid crossing reservation lands.

Wherever the Oliver 1 Route does follow an existing transmission line corridor it could be constructed as double circuit, requiring 0 to 20 more feet of additional new ROW, or it could be built parallel to the existing line, which would require 75 to 120 feet of new ROW. In this EIS, these two design options are labeled as the Oliver 1, primarily double circuit option and the Oliver 1, primarily parallel circuit option. Wherever any of the proposed segments follows a corridor of an existing railroad or pipeline, the new transmission line would be constructed parallel to the existing ROW and would require 98 to 132 feet of new ROW.[179]

Tables 6-1 and 6-2 list all of the segments comprising the Oliver 1 Route as proposed and other information about the physical appearance of each segment.

---

[179] Parallel options do not overlap the ROW of the neighboring transmission line, railroad or gas pipeline.

Table 6-1 Oliver 1 Route (primarily double circuit)

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
397x	5500	double circuit, single pole	TL, RR & partial R	NA	15-20	200-271	125-135
394x	3200	double circuit, single pole & single circuit, single pole or H-frame	TL, RR	NA	0-20	200-230	125-135
393	32500	single circuit, single pole or -frame	RR	6-12 or 6-13	98-122	198-222	85-105
392	7700	single circuit, single pole or H-frame	Partial RR	6-17 or 6-18 and 6-12 or 6-13	98-150	150-222	85-105
385x	13300	double circuit, single pole	TL, R	NA	0-10	176-196	125-135
379x	9300	double circuit, single pole	TL partial, PL	6-11 and NA	0-120	120-230	125-135
377x	8200	double circuit, single pole	TL, PL	NA	0-10	190-230	125-135
372x	96400	double circuit, single pole	TL, partial PL	6-5 and NA	0-20	120-230	125-135
367x	31400	double circuit, single pole	Both TL, PL, partial	6-5 and NA	0-120	120-230	125-135
360x	33900	double circuit, single pole	TL, PL, partial	6-5 and NA	0-10	120-230	125-135
359#	8300	double circuit, single pole	TL, PL, partial RR & R	6-5 and 6-6 or 6-7	0-10	190-396	125-135
357x	54900	double circuit, single pole	TL, PL, partial RR- and R	NA	0-10	190-396	125-135
352x	6300	double circuit, single pole	TL	6-5	0-20	120	125-135
349x	1500	double circuit, single pole	TL	6-5	0-20	120	125-135
346x	9000	double circuit, single pole	TL, partial PL	6-5 and NA	0-20	120-230	125-135
343x	4000	double circuit, single pole	TL, partial PL	6-5 and NA	0-20	120-230	125-135
341x	20200	double circuit, single pole and single circuit single pole or H frame	Mostly TL, RR & PL	6-5 and NA	0-120	120-230	85-135
340x*	8700	double circuit, single pole	TL, PL most	6-5 and NA	0-120	120-230	65-135
337c	11100	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
337a	16100	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
334a	2300	single circuit , single pole or H-frame	RR	6-12 or 6-13	98-122	198-222	85-105
328	9700	single circuit , single pole or H-frame	RR	6-12 or 6-13	98-122	198-222	85-105

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
324b and c	41100	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
323 a & b	11200	single circuit , single pole or H-frame	PL	6-10 or 6-11	108-132	188-232	85-105
319	4700	single circuit , single pole or H-frame	PL	6-10 or 6-11	108-132	188-232	85-105
317	5500	single circuit , single pole or H-frame	PL	6-10 or 6-11	108-132	188-232	85-105
316	13500	single circuit , single pole or H-frame	PL	6-10 or 6-11	108-132	188-232	85-105
315	10000	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
311	14200	single circuit , single pole or H-frame	PL	6-10 or 6-11	108-132	188-232	85-105
Total	493700						

*TL=Transmission Line, RR=Railroad, R=Road, PL=Pipeline, NA = no figure available

Table 6-2 Oliver 1 Route (some segments constructed as parallel circuits)

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
397x	5500	double circuit, single pole	TL	NA	15-20	200-271	125-135
394x	3200	double circuit, single pole	TL, RR	NA	0-20	200-230	125-135
393	32500	single circuit, single pole or H-frame	RR	6-12 or 6-13	98-150	150-222	85-105
392	7700	single circuit, single pole or H-frame	Partial RR	6-17 or 6-18 6-12 or 6-13	98-122	198-222	85-105
385y or z	13300	parallel, H-frame or single pole	TL, R	NA	75-115	256-296	85-105
379y or z	9300	parallel, H-frame or single pole	TL, PL	NA	75-115	270-330	85-105
377y or z	8200	parallel, H-frame or single pole	TL, PL	NA	75-115	270-330	85-105
372y or z	96400	parallel, H-frame or single pole	TL, partial PL	6-6, 6-7, and NA	75-115	190-330	85-105
367y or z	31400	parallel, H-frame or single pole	Partial TL, PL	6-17, 6-18 and NA	75-150	75-330	85-105
360y or z	33900	parallel, H-frame or single pole	TL, partial PL	6-6 and 6-7 and NA	75-115	190-330	85-105
359#	8300	parallel, H-frame or single pole, part double circuit	TL, PL, partial RR and R	NA	0-115	270-596	85-135
357y or z	54900	parallel, H-frame or single pole	TL, PL, RR-most, R-partial		105-115	290-490	85-105

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
352x	6300	double circuit, single pole	TL	6-5	0-20	120	125-135
349x	1500	double circuit, single pole	TL	6-5	20-30	120	125-135
346x	9000	double circuit, single pole	TL, partial PL	6-5 and NA	20-30	120-200	125-135
343x	4000	double circuit, single pole	TL, partial PL	6-5 and NA	20-30	120-200	125-135
341#	20200	Part parallel H_frame or single pole double circuit, single pole	Mostly TL, RR and PL	6-17, 6-18 and NA	0-120	75-330	85-135
340y or z	8700	parallel, H-frame or single pole	TL, PL	NA	75-115	190-330	85-105
337c	11100	single circuit , single pole or H-frame	none	6-17 or 6-18	120-150	120-150	85-105
337a	16100	single circuit , single pole or H-frame	none	6-17 or 6-18	120-150	120-150	85-105
334a	2300	single circuit , single pole or H-frame	RR	6-12 or 6-13	98-122	198-222	85-105
328	9700	single circuit , single pole or H-frame	RR	6-12 or 6-13	98-122	198-222	85-105
324 a, b, and c	41100	single circuit , single pole or H-frame	none	6-17 or 6-18	120-150	120-150	85-105
323	11200	single circuit , single pole or H-frame	PL	6-10 or 6-11	108-132	188-212	85-105
319	4700	single circuit , single pole or H-frame	PL	6-10 or 6-11	108-132	188-212	85-105
317	5500	single circuit , single pole or H-frame	PL	6-10 or 6-11	108-132	188-212	85-105
316	13500	single circuit , single pole or H-frame	PL	6-10 or 6-11	108-132	188-212	85-105
315	10000	single circuit , single pole or H-frame	none	6-17 or 6-18	120-150	120-150	85-105
311	14200	single circuit , single pole or H-frame	PL	6-10 or 6-11	108-132	188-212	85-105
Total	493700						

*TL=Transmission Line, RR=Railroad, R=Road, PL=Pipeline, NA = no figure available

Oliver 2 Route

This route, which is 99.2 miles long, primarily follows a cross-country course, occasionally paralleling an existing transmission line, railroad or pipeline corridor. Wherever the Oliver 2 Route follows a transmission line corridor, the new line could be constructed as a double circuit requiring 20 more feet of new ROW, or as a parallel line requiring 120-150 more feet of additional ROW. In this EIS, these two design options are referred to as the Oliver 2 double circuit option and the Oliver 2 parallel circuit option.

Wherever any of the proposed segments follows a corridor of an existing railroad or pipeline, the new transmission line would be constructed parallel to the existing ROW and would require 120 to 150 feet of new ROW.

Tables 6-3 and 6-4 list all of the segments comprising the Oliver 2 Route as proposed and other information about the physical appearance of each segment.

Table 6-3 Oliver 2 Route (double circuit)

Segment Number	Length Feet	Line Design	0ther Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
397x	5500	double circuit, single pole	TL, RR and partial R	NA	15-20	200-271	125-135
396	11300	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
395	9400	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
384	31100	single circuit, single pole or H-frame	PL partial	6-17 or 6-18 or 6-10 or 6-11	108-132	120-232	85-105
382	11900	single circuit, single pole or H-frame	PL partial	6-17 or 6-18 or 6-10 or 6-11	108-132	120-232	85-105
378	14500	single circuit, single pole or H-frame	PL	6-10 or 6-11	108-132	188-232	85-105
376	8100	single circuit, single pole or H-frame	PL	6-10 or 6-11	108-132	188-232	85-105
373b	18200	single circuit, single pole or H-frame	PL	6-10 or 6-11	108-132	188-232	85-105
399	65000	single circuit, single pole or H-frame	R	6-14 or 6-15	91-115	157-81	85-105
398	25200	single circuit, single pole or H-frame	partial R and PL	6-10 or 6-11 or 6-14 or 6-15 6-17 and 6-18	91-132	157-232	85-105
371	3900	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
368	11500	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
365	21800	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
363	14400	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
362	7200	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
356	57200	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
355	21300	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
353	1600	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
351	1500	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
347x	12400	single circuit, single pole or H-frame	RR most, PL partial	6-17 or 6-18 6-10 or 6-11	98-132	120-322	85-105
344x	2300	single circuit, single pole or H-frame	RR	16-12 or 6-13	98-122	198-222	85-105
341x	20200	double circuit, single pole and single circuit, single pole or H-frame	Mostly TL, RR & PL	6-5 and NA	0-120	120-430	85-135
340x*	8700	double circuit, single pole	TL, PL most	NA	0-120	120-230	125-135
339	4900	single circuit , single pole or H-frame	partial PL	6-17 or 6-18 and 6-10 or 6-11	108-150	120-232	85-105
332cx	17100	double circuit, single pole	TL	6-5	0-20	120	125-135
332ax	11100	double circuit, single pole	TL and PL most	6-5 and NA	0-30	120-232	125-135
330x	2900	double circuit, single pole	TL, PL	NA	0-15	188-232	125-135
329	10200	single circuit , single pole or H-frame	Partial PL	6-17 or 6-18 and 6-10 or 6-11	108-132	150-208	85-105
326	25900	single circuit , single pole or H-frame	partial R	6-17 or 6-18 and 6-14 or 6-15	91-120	120-181	85-105
325	500	single circuit , single pole or H-frame	PL	6-10 or 6-11	108-132	188-232	85-105
323	11200	single circuit , single pole or H-frame	PL	6-10 or 6-11	108-132	188-232	85-105
322	13000	single circuit , single pole or H-frame	none	6-17-6-18	120-150	120-150	85-105
321	16900	single circuit , single pole or H-frame	none	6-17-6-18	120-150	120-150	85-105
312x	26000	double circuit, single pole	TL	6-5	0-30	120	125-135
Total	523900						

*TL=Transmission Line, RR=Railroad, R=Road, PL=Pipeline, NA = no figure available

Table 6-4 Oliver 2 Route (some segments constructed as parallel circuit)

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
341#	20200	Part parallel H-frame or single pole double circuit, single pole	Mostly TL, RR and PL	6-17, 6-18 and NA	0-120	75-330	85-135
340y or z	8700	Parallel single circuit , single pole or H-frame	TL and PL most	6-6 or 6-7 and NA	105-115	205-285	125-135
312y or z	26000	Parallel single circuit , single pole or H-frame	TL	6-6 or 6-7	90-120	190-215	125-135
Total	523900						

*TL=Transmission Line, PL=Pipeline, NA = no figure available

Oliver 3 Route

The Oliver 3 Route, which is 91.5 miles long, was developed by Commission staff in order to maximize potential corridor sharing opportunities and reduce potential environmental impacts. Wis. Stat. § 196.491(3)(5)3r. requires that high-voltage transmission line projects proposed to increase import capability must, to the extent practicable, use existing ROW and must minimize environmental impact in a manner consistent with achieving reasonable electric rates. In the EIS this route is described as the Oliver 3 double circuit option. It follows the same path and includes the same line design options as the proposed Oliver 1 Route, except that it follows an existing transmission line corridor through the LCO Reservation and continues to follow this existing transmission line further south toward Exeland. The Oliver 1 and 2 Routes do not follow the existing transmission corridor south of the reservation because the direction taken by these routes brings them in close proximity to an existing pipeline corridor, rather than the transmission corridor. Use of the existing transmission line corridor through the LCO Reservation lands, especially if built as a double circuit design, would minimize the need for new ROW and would affect fewer acres of wetlands, forests, and agricultural land. About 20 feet of additional ROW would be needed where the route crosses reservation lands. (Utilities may not have condemnation authority on tribal lands because of tribal sovereignty. *California v. Cabazon Band of Mission Indians*, 480 US 202, 207 (1987).)

Wherever any of the proposed segments follow a corridor of an existing railroad or pipeline, the new transmission line would be constructed parallel to the existing ROW and would require 98 to 132 feet of new ROW.

Table 6-5 lists all of the segments comprising the Oliver 3 Route as proposed and other information about the physical appearance of each segment.

Table 6-5 Oliver 3 Route (double circuit)

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
397x	5500	double circuit, single pole	TL, RR & partial R	NA	15-20	200-271	125-135
394x	3200	double circuit, single pole & single circuit, single pole or H-frame	TL, RR	NA	0-20	200-230	125-135
393	32500	single circuit, single pole or H-frame	RR	6-12 or 6-13	98-122	198-222	85-105
392	7700	single circuit, single pole or H-frame	Partial RR	6-17 or 6-18 and 6-12 or 6-13	98-150	150-222	85-105
385x	13300	double circuit, single pole	TL, R	NA	0-10	176-196	125-135
379x	9300	double circuit, single pole	TL partial, PL	6-11 and NA	0-120	120-230	125-135
377x	8200	double circuit, single pole	TL, PL	NA	0-10	190-230	125-135
372x	96400	double circuit, single pole	TL, partial PL	6-5 and NA	0-20	120-230	125-135
367x	31400	double circuit, single pole	Both TL, PL, partial	6-5 and NA	0-120	120-230	125-135
360x	33900	double circuit, single pole	TL, PL, partial	6-5 and NA	0-10	120-230	125-135
359#	8300	double circuit, single pole	TL, PL, partial RR & R	6-5 and 6-6 or 6-7	0-10	190-396	125-135
357x	54900	double circuit, single pole	TL, PL, partial RR- and R-	NA	0-10	190-396	125-135
352x	6300	double circuit, single pole	TL	6-5	0-20	120	125-135
349x	1500	double circuit, single pole	TL	6-5	0-20	120	125-135
346x	9000	double circuit, single pole	TL, partial PL	6-5 and NA	0-20	120-230	125-135
343x	4000	double circuit, single pole	TL, partial PL	6-5 and NA	0-20	120-230	125-135
341x	20200	double circuit, single pole and single circuit single pole or H frame	Mostly TL, RR & PL	6-5 and NA	0-120	120-230	85-135
340x*	8700	double circuit, single pole	TL, PL mostly	6-5 and NA	0-120	120-230	65-135
339	4900	single circuit , single pole or H-frame	PL-partial	6-17 or 6-18 and 6-10 or 6-11	108-150	120-232	85-105
332cx	17100	double circuit, single pole	TL	6-5	0-20	120	125-135
332ax	11100	double circuit, single pole	TL, PL-mostly	6-5 and NA	0-30	120-232	125-135
330x	2900	double circuit, single pole	TL, PL	NA	0-15	188-232	125-135

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
320x	67000	double circuit, single pole and single circuit, single pole or H-frame	TL-partial	6-5 and 6-17 or 6-18	0-120	120-150	85-135
312x	26000	double circuit, single pole	TL	6-5	0-30	120	125-135
Total	490000						

*TL=Transmission Line, RR=Railroad, R=Road, PL=Pipeline, NA = no figure available

The Tripoli Sector

There are four route options for the proposed 345 kV line in the Tripoli Route Sector (Exeland to Weston). The Tripoli 1, Tripoli 2, and Tripoli 3 Routes were proposed by the applicants and are included in their application. The Tripoli 4 Route has been developed and analyzed by Commission staff in an attempt to reduce impacts to OERW.

Tripoli 1 Route

This route is mainly cross-country, although some corridor sharing takes place. About 13 percent (16.4 miles) of the overall length of the route (130.9 miles) is adjacent to other facilities. Where it does share corridors, it is mostly adjacent to existing electric transmission lines and roads. A few segments follow an existing petroleum pipeline. The route begins near Exeland and follows an electric transmission line south for a short distance until it meets a petroleum pipeline. The route then follows the pipeline corridor south for a few miles, before turning east and running cross-country until it joins an existing electric transmission corridor northeast of Ladysmith. This corridor is followed east a few miles before the route leaves the transmission line corridor and proceeds east, cross-country, paralleling the line (about 0.75 miles to the north of it) to a point near Prentice. The Tripoli 1 Route then turns south and continues past Prentice, paralleling an electric transmission line and a road for part of this distance. The route then turns east again and continues cross-country toward the Lincoln-Price County line, where there are two proposed sites for the new Tripoli Substation. In the vicinity of these substation sites, the route proceeds south, mostly cross-country, except for a few miles along a road. Southeast of Edgar the route turns east and continues cross-country to the Weston Substation. A portion of the route just west of Weston shares an electric transmission line corridor, and a short segment lies adjacent to a road and a petroleum pipeline.

Where the route is adjacent to electric transmission lines, the new line could be built as a double circuit line, or it could be built adjacent (parallel) to the existing line on either H-frame or single pole structures. The applicants are proposing to relocate the existing NSP 115 kV transmission line between the Flambeau River and Prentice and double circuit it with the proposed 345 kV transmission line. Doing so would require that several short sections of 115 kV lines be built adjacent to roads to connect the relocated NSP transmission line with existing substations. Up to 20 feet of additional ROW may be required adjacent to existing electric line ROW for double circuit construction. Where the line would be constructed parallel to an existing transmission line, rail line, pipeline, or road, between 91 and 132 feet of additional new ROW would be required.

See Table 6-6 for information about the physical appearance of each segment of the route, as proposed by the utilities.

Table 6-6 Tripoli 1 Route (double circuit)

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
1a	11300	double circuit, single pole	TL	6-19	0	190	125-135
1b	4500	double circuit, single pole	TL	6-19	0	190	125-135
7a	4400	single circuit, single pole or H-frame	PL, R	6-10 or NA	108-132	208-232	85-105
49	4900	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
14b	55600	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
20	56600	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
25	25100	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
27	12400	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
31	17400	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
34	123800	single circuit , single pole or H-frame	R-partial	6-17 or 6-18, and 6-14 or 6-15	91-150	120-181	85-105
38	3700	double circuit, single pole or single circuit , single pole or H-frame	None	6-17 or 6-18, or 6-19	120-150	120-150	85-135
107a	1100	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
107b	21200	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
109	1100	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
111	15200	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
119	22200	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
123	14900	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
127	7200	double circuit, single pole partial single circuit, single pole or H-frame partial	TL-partial	6-17 or 6-18, and 6-5	20-150	120-150	85-135

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
129	10300	double circuit, single pole	R-partial	6-19 and NA	91-120	120-157	125-135
131	46800	double circuit, single pole	None	6-19	120	120	125-135
135	85900	double circuit, single pole	None	6-19	120	120	125-135
140	5800	double circuit,. single pole	None	6-19	120	120	125-135
153a	10800	double circuit, single pole	TL	6-5	20	120	125-135
153b	6400	double circuit, single pole	TL	6-5	20	120	125-135
144	16700	double circuit, single pole-partial single circuit, single pole or H-frame-partial	TL-partial	6-17 or 6-18, and 6-5	20-150	120-150	85-135
145a	19500	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
145b3	7200	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
145b1	16400	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
149b	9400	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
302'	7300	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
301b	2900	single circuit , single pole or H-frame	PL	6-10 or 6-11	108-132	188-212	85-105
303	7100	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
308'	14400	single circuit , single pole or H-frame	PL-most	6-10 or 6-11, and 6-17 or 6-18	120-150	120-150	85-105
310**	13700	double circuit, single pole	TL	6-5	20	120	125-135
159+	3500	single circuit, single pole	R	NA	43	109	70-100
161+	4500	single circuit , single pole	R	NA	43	109	70-100
Total	691200						

*TL=Transmission Line, RR=Railroad, R=Road, PL=Pipeline, NA = no figure available.

**This segment would not be needed if the selected Oliver sector route uses segment 311.

"+" denotes 115 kV segments built to connect a relocated NSP line to the existing transmission system.

Tripoli 2 Route

This route is predominantly cross-country. It is 137.6 miles long. Electric transmission lines and short lengths of road are followed where corridors are shared. The route begins south of Exeland and follows an electric transmission line north for a short distance to a point near Exeland. The route then proceeds east cross-country, until it crosses the Flambeau River. The route then heads southeast until it meets an existing NSP 115 kV line northwest of Ingram. After following this line for a short distance the route drifts southward as it proceeds east, cross-country, to two proposed sites for the Tripoli Substation in eastern Price County. Turning south, the Tripoli 2 Route extends cross-country through eastern Taylor County, until it reaches a point southwest of Edgar. Passing south of Edgar, the route turns and continues south for a few more miles. It then turns east and continues cross-country to the Weston Substation. A portion of the route just west of Weston shares an electric transmission line corridor.

Where the route is adjacent to electric transmission lines, the new line would be built as a double circuit line on a single pole structure. The applicants are proposing to relocate the existing NSP 115 kV transmission line between the Flambeau River and Prentice and double circuit it with the proposed 345 kV transmission line. Doing so would require that several short sections of 115 kV lines be built adjacent to roads to connect the relocated NSP transmission line with existing substations, and that another section be built to reconnect the line at its eastern end. The section at the eastern end could be partially double circuited with an existing 69 kV line.

Up to 20 feet of additional ROW may be required adjacent to existing electric line ROW for double circuit construction. Where the route is adjacent to a road, between 91 and 115 additional feet of ROW would be required, depending on whether H-frame structures or single pole structures are used.

See Table 6-7 for information about the physical appearance of each segment of the route as proposed by the utilities.

Table 6-7 Tripoli 2 Route (double circuit)

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
1a	11300	double circuit, single pole	TL	6-19	0	190	125-135
1b	4500	double circuit, single pole	TL	6-19	0	190	125-135
8a	3100	double circuit, single pole	TL	6-19	0	190	125-135
8b	2000	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
11	46300	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
16	18400	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
18	1500	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
21	16200	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
23a	16900	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
23b	7200	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
24b'	54100	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
29	182300	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
110	1300	double circuit, single pole	None	6-19	120	120	125-135
112	12900	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
118	20900	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
122	18400	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
126'	129500	double circuit, single pole	R-partial	6-19 and NA	91-120	157-120	125-135
136	3100	double circuit, single pole	None	6-19	120	120	125-135
139a	3000	double circuit, single pole	None	6-19	120	120	125-135
139b	5400	double circuit, single pole	TL	6-5	20	120	125-135
154	4900	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
155a	11200	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
155b	27900	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
147	61300	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
309	12500	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
310**	13700	double circuit, single pole	TL	6-5	20	120	125-135
125+	4500	double circuit, single pole	TL	NA	0	100	85-110
127+	7100	double circuit, single pole-partial single circuit, single pole or H-frame-partial	TL-partial	NA and NA	0-80	80-100	70-110
158+	14800	single circuit, single pole	Road	NA	43	109	70-100
160+	10500	single circuit, single pole	Road	NA	43	109	70-100
Total	726700						

*TL=Transmission Line

**This segment would not be needed if the selected Oliver sector roué uses segment 312.

"+" denotes 115 kV segments built to connect a relocated NSP line to the existing transmission system.

Tripoli 3 Route

Of the four Tripoli routes, this route and the Tripoli 4 Route have the most corridor sharing, but over two-thirds of this route is still cross-country. The route is 132.4 miles long. Most shared corridor is adjacent to electric transmission line ROW; smaller sections are adjacent to road or railroad. The route begins south of Exeland and follows an electric transmission line north for a short distance to a point near Exeland. The route then follows a rail corridor as it heads south for a short distance. The route then turns east and continues cross-country, until it joins an existing electric transmission corridor northeast of Ladysmith, where it crosses the Flambeau River. The route then follows the NSP 115 kV line east to Prentice. Northwest of Prentice, the route turns south and continues past Prentice, paralleling an electric transmission line for a short distance. The route then turns east once again and heads cross-country to two proposed sites for the Tripoli Substation in eastern Price County. Turning south, the route extends cross-country through eastern Taylor County, until it reaches a point southwest of Edgar. Passing south of Edgar, the route continues east, cross-country, to the Weston Substation. A relatively short distance of existing electric transmission line would be double circuited leading into the plant site.

Where the route is adjacent to electric transmission lines, the new line would be built as a double circuit line on single pole structures. Up to 20 feet of additional ROW may be required for double circuit construction. Where the route follows a railroad corridor, the new transmission line would be built parallel to the existing corridor and would require between 98 and

122 additional feet of ROW. See Table 6-8 for information about the physical appearance of each segment of the route, as proposed by the utilities.

Table 6-8 Tripoli 3 Route (double circuit)

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
1a	11300	double circuit, single pole	TL	6-19	0	190	125-135
48	10200	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
14b	55600	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
19	900	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
21	16200	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
23a	16900	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
23b	7200	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
24b'	54100	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
29	182300	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
110	1300	double circuit , single pole or H-frame	None	6-19	120	120	125-135
112	12900	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
118	20900	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
122	18400	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
125	4500	double circuit, single pole	TL	6-5	20	120	125-135
127	7200	double circuit, single pole-partial single circuit, single pole or H-frame-partial	TL-partial	6-17 or 6-18 and 6-5	20-150	120-150	85-135
130	52300	double circuit, single pole	TL, R-partial	6-5 and NA	10-20	120-132	125-135
156	79300	double circuit, single pole	TL, R-partial	6-5 and NA	10-20	120-132	125-135
139b	5400	double circuit, single pole	TL	6-5	20	120	125-135
153a	10800	double circuit, single pole	TL	6-5	20	120	125-135
153b	6400	double circuit, single pole	TL	6-5	20	120	125-135

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
144	16700	double circuit, single pole-partial single circuit, single pole or H-frame-partial	TL-partial	6-17 or 6-18 and 6-5	20-150	120-150	85-135
145a	19500	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
145b3	7200	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
145b1	16400	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
149b	9400	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
152	2700	single circuit , single pole or H-frame	RR	6-12 or 6-13	120-150	120-150	85-105
305	5400	single circuit , single pole or H-frame	RR	6-12 or 6-13	98-122	198-222	85-105
307	21500	single circuit , single pole or H-frame	RR-partial	6-12 or 6-13, and 6-17 or 6-18	98-150	120-222	85-105
309	12500	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
310**	13700	double circuit, single pole	TL	6-5	20	120	125-135
Total	683600						

*TL=Transmission Line, RR=Railroad, R=Road, PL=Pipeline, NA = no figure available.

**This segment would not be needed if the selected Oliver sector route uses segment 312.

Tripoli 4 Route

Of the four Tripoli routes, this route and the Tripoli 3 Route have the most corridor sharing, but over two-thirds of this route is still cross-country. The route is 132.2 miles long. Most shared corridor is adjacent to electric transmission line ROW; smaller sections are adjacent to road or pipeline. The route begins near Exeland and follows an electric transmission line south for a short distance until it meets a petroleum pipeline. The route then follows the pipeline corridor south for a few miles, before turning east and running cross-country until it joins an existing electric transmission corridor northeast of Ladysmith, where it crosses the Flambeau River. The route then follows the NSP 115 kV line east to Prentice. Northwest of Prentice, the route turns south and continues past Prentice, paralleling an electric transmission line for a short distance. The route then turns east once again and heads cross-country to two proposed sites for the Tripoli Substation in eastern Price County. Turning south, the route extends cross-country through eastern Taylor County, until it reaches a point southwest of Edgar. Passing south of Edgar, the route turns and continues south for a few more miles. It then turns east and continues cross-country to the Weston Substation. A portion of the route just west of Weston shares an electric transmission line corridor.

Where the route is adjacent to electric transmission lines, the new line would be built as a double circuit line on single pole structures. Up to 20 feet of additional ROW may be required for double circuit construction. Where the route follows a pipeline corridor, the new transmission line would be built parallel to the existing corridor and would require between 108 and 132 additional feet of ROW. See Table 6-9 for information about the physical appearance of each segment of the route, as proposed by the utilities.

Table 6-9 Tripoli 4 Route (double circuit)

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
1a	11300	double circuit, single pole	TL	6-19	0	190	125-135
1b	4500	double circuit, single pole	TL	6-19	0	190	125-135
8a	3100	double circuit, single pole	TL	6-19	0	190	
8b	2000	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	
11	46300	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	
16	18400	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	
18	1500	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	
21	16200	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	
23a	16900	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	
23b	7200	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	
24b'	54100	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	
29	182300	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	125-135
110	1300	double circuit , single pole or H-frame	None	6-19	120	120	85-105
112	12900	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
118	20900	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
122	18400	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
125	4500	double circuit, single pole	TL	6-5	20	120	85-105
127	7200	double circuit, single pole-partial single circuit, single pole or H-frame-partial	TL-partial	6-17 or 6-18 and 6-5	20-150	120-150	85-105

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
130	52300	double circuit, single pole	TL, R-partial	6-5 and NA	10-20	120-132	85-105
156	79300	double circuit, single pole	TL, R-partial	6-5 and NA	10-20	120-132	85-105
139b	5400	double circuit, single pole	TL	6-5	20	120	125-135
153a	10800	double circuit, single pole	TL	6-5	20	120	125-135
153b	6400	double circuit, single pole	TL	6-5	20	120	125-135
144	16700	double circuit, single pole-partial single circuit, single pole or H-frame-partial	TL-partial	6-17 or 6-18 and 6-5	20-150	120-150	85-135
145a	19500	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
145b3	7200	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
145b1	16400	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
149b	9400	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
302`	7300	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
301b	2900	single circuit, single pole or H-frame	PL	6-10 or 6-11	108-132	188-212	85-105
303	7100	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
308`	14400	single circuit, single pole or H-frame	PL-most	6-10 or 6-11 and 6-17 or 6-18	108-150	120-212	85-105
310**	13700	double circuit, single pole	TL	6-5	20	120	125-135
Total	697800						

*TL=Transmission Line, RR=Railroad, R=Road, PL=Pipeline, NA = no figure available.

**This segment would not be needed if the selected Oliver sector route uses segment 311.

The Owen Sector

There are four route options for the proposed 345 kV line in the Owen Route Sector (Exeland to Weston). Two routes were proposed by the applicants. They are Owen 1 and Owen 2. In an attempt to reduce environmental impacts and include other route alternatives that offer more corridor-sharing opportunities, Commission staff has developed and analyzed two additional routes, the Owen 3 and Owen 4 Routes.

Owen 1 Route

This route, 124.7 miles long, is a mix of cross-country and corridor-sharing segments. Less than half the route, 51.1 miles, is adjacent to other facilities. Where it does share corridors, it follows mostly electric transmission line and railroad corridors. Several segments parallel existing petroleum pipelines. The Owen 1 Route begins south of Exeland and follows an electric transmission line north for a short distance to a point near Exeland.

The route then follows a railroad corridor as it heads south. The route continues east, cross-country, until it joins an existing electric transmission corridor northeast of Ladysmith. This transmission line ROW is followed southward until it joins a railroad grade south of Sheldon. The railroad corridor is followed to the southeast, with a few deviations, to a point northwest of Owen. The route then heads cross-country east and south to the Weston Substation. Portions of the route between Abbotsford and Edgar and also just west of Weston follow an electric transmission line corridor.

Where the route follows electric transmission lines, the new line could be built as a double circuit line, or it could be built adjacent (parallel) to the existing line on either H-frame or single pole structures. Up to 40 feet of additional ROW would be required for double circuit construction, and 75 to 115 feet for parallel construction.

Where the route follows a railroad, a pipeline, or a road, the new line would be built parallel to the existing corridor on either H-frame or single pole structures. Between 91 and 132 additional feet of ROW would be required in these locations.

Tables 6-10 and 6-11 list all of the segments comprising the Owen 1 Route as proposed and other information about the physical appearance of each segment.

Table 6-10 Owen 1 Route (double circuit)

Segment Number	Length Feet	Line Design	Other Facilities at Location	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
1a	11300	double circuit, single pole	TL	6-19	0	190	125-135
1b	4500	double circuit, single pole	TL	6-19	0	190	125-135
7a	4400	single circuit, single pole or H-frame	PL, R	6-10 or NA	108-132	208-232	85-105
49	4900	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
14b	55600	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
19	900	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
21	16200	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
23a	16900	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
23b	7200	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
202a	7100	double circuit, single pole-partial single circuit, single pole or H-frame-partial	TL-partial	6-17 or 6-18 and 6-5	40-150	120-150	85-135
202c	34900	double circuit, single pole	TL	6-5	40	120	125-135
203	129500	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
221'	17800	single circuit , single pole or H-frame	RR	6-12 or 6-13	98-122	198-222	85-105
225	12800	single circuit , single pole or H-frame	RR	6-12 or 6-13	98-122	198-222	85-105
227	3600	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
229	20600	single circuit , single pole or H-frame	PL, most	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
230	2500	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
231	9800	single circuit , single pole or H-frame	RR	6-12 or 6-13	98-122	198-222	85-105
233	2500	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
235	23900	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
236	53800	single circuit , single pole or H-frame	RR-partial	6-12 or 6-13, and 6-17 or 6-18	98-150	120-372	85-105
243	89400	double circuit, single pole	TL	6-5	0	120	125-135

Segment Number	Length Feet	Line Design	Other Facilities at Location	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
142	3200	double circuit, single pole	TL	6-5	0	120	125-135
144	16700	double circuit, single pole-partial single circuit, single pole or H-frame-partial	TL-partial	6-17 or 6-18 and 6-5	20-150	120-150	85-135
145a	19500	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
145b3	7200	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
145b1	16400	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
149b	9400	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
152	2700	single circuit , single pole or H-frame	RR	6-12 or 6-13	98-122	198-222	85-105
305	5400	single circuit , single pole or H-frame	RR	6-12 or 6-13	98-122	198-222	85-105
307	21500	single circuit , single pole or H-frame	RR-partial	6-12 or 6-13, and 6-17 or 6-18	98-150	120-222	85-105
309	12600	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
310**	13700	double circuit, single pole	TL	6-5	0	120	125-135
Total	658400						

*TL=Transmission Line, RR=Railroad, R=Road, PL=Pipeline

** This segment would not be needed if the selected Oliver sector route uses segment 312.

Table 6-11 Owen 1 Route (parallel)

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
1a	11300	double circuit, single pole	TL	6-19	0	190	125-135
1b	4500	double circuit, single pole	TL	6-19	0	190	125-135
7a	4400	single circuit, single pole or H-frame	PL, Road	6-10 or NA	108-132	208-232	85-105
49	4900	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
14b	55600	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
19	900	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
21	16200	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
23a	16900	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
23b	7200	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
202a	7100	single circuit , single pole or H-frame	TL-partial	6-17 or 6-18, and 6-8 or 6-9	90-150	120-195	85-105
202c	34900	single circuit , single pole or H-frame	TL	6-8 or 6-9	90-115	170-195	85-105
203	129500	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
221'	17800	single circuit , single pole or H-frame	RR	6-12 or 6-13	98-122	198-222	85-105
225	12800	single circuit , single pole or H-frame	RR	6-12 or 6-13	98-122	198-222	85-105
227	3600	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
229	20600	single circuit , single pole or H-frame	PL	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
230	2500	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
231	9800	single circuit , single pole or H-frame	RR	6-12 or 6-13	98-122	198-222	85-105
233	2500	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
235	23900	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
236	53800	single circuit , single pole or H-frame	RR-partial	6-12 or 6-13, and 6-17 or 6-18	98-150	120-372	85-105
243	89400	single circuit , single pole or H-frame	TL	6-6 or 6-7	75-100	205-230	85-105

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
142	3100	single circuit , single pole or H-frame	TL	6-6 or 6-7	75-100	205-230	85-105
144	16700	double circuit, single pole-partial single circuit, single pole or H-frame-partial	TL-partial	6-17 or 6-18, and 6-8 or 6-9	20-150	120-150	85-135
145a	19500	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
145b3	7200	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
145b	21800	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
149b	9400	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
152	2700	single circuit , single pole or H-frame	RR	6-12 or 6-13	98-122	198-222	85-105
305	5400	single circuit , single pole or H-frame	RR	6-12 or 6-13	98-122	198-222	85-105
307	21500	single circuit , single pole or H-frame	RR	6-12 or 6-13 and 6-17 or 6-18	98-150	120--222	85-105
309	12600	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
310**	13700	single circuit, single pole or H-frame	TL	6-5	90-115	190-205	85-105
Total	658300						

*TL=Transmission Line, RR=Railroad, R=Road, PL=Pipeline

**This segment would not be needed if the selected Oliver sector route uses segment 312.

Owen 2 Route

This route, 116.4 miles long, consists of nearly equal portions of corridor sharing and new cross-country construction. Existing facilities followed by the route include a petroleum pipeline and relatively short lengths of electric transmission line and railroad corridors. The route begins near Exeland and follows an electric transmission line south for a short distance until it meets a petroleum pipeline. The route then follows the pipeline southeast to a point northwest of Owen. The route turns south and continues cross-country to an existing electric transmission line ROW that passes south of Owen. The transmission line ROW is followed east to a railroad corridor. The Owen 2 Route follows the rail line southeast to a point near Riplinger. The route then heads east, cross-country, to the Weston Substation. A relatively short distance of existing electric transmission line would be double circuited leading into the plant site.

Where the route is adjacent to electric transmission lines, the new line could be built as a double circuit line, or it could be built adjacent (parallel) to the existing line on either H-frame or single pole structures. Up to 30 feet of additional ROW would be required for double circuit construction, and 85 to 115 feet for parallel construction. Where the route is adjacent to existing railroad, pipeline, or road, the new line would require between 91 and 132 additional feet of ROW.

Table 6-12 lists all of the segments comprising the Owen 2 Route, as proposed and other information about the physical appearance of each segment.

Table 6-12 Owen 2 Route (double circuit)

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
1a	11300	double circuit, single pole	TL	6-19	0	190	125-135
1b	4500	double circuit, single pole	TL	6-19	0	190	125-135
8a	3100	double circuit, single pole	TL	6-19	0	190	125-135
8b	2000	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
11	46300	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
201	163900	single circuit , single pole or H-frame	RR-partial	6-17 or 6-18, and 6-12 or 6-13	98-150	120-222	85-105
209	16200	single circuit , single pole or H-frame	RR	6-12 or 6-13	98-122	198-222	85-105
213'	42500	double circuit, single pole-partial single circuit, single pole or H-frame-partial	TL-partial	6-17 or 6-18, and 6-5	30-60	120-150	85-135
223	33500	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
226	16800	single circuit , single pole or H-frame	PL	6-10 or 6-11	108-132	188-212	85-105
229	20600	single circuit , single pole or H-frame	PL, most	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
230	2500	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
231	9800	single circuit , single pole or H-frame	RR	6-12 or 6-13	98-122	198-222	85-105
233	2500	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
235	23900	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
237	48400	single circuit , single pole or H-frame	PL-partial	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
239	31800	single circuit , single pole or H-frame	PL-partial	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
240	5800	single circuit , single pole or H-frame	PL-partial	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
242'	83100	double circuit, single pole-partial single circuit, single pole or H-frame-partial	TL-partial PL-partial	6-10 or 6-11, and 6-17 or 6-18, and NA	108-150	120-212	85-135
301a'	7900	single circuit , single pole or H-frame	PL	6-10 or 6-11	108-132	188-212	85-105
301b	2900	single circuit , single pole or H-frame	PL	6-10 or 6-11	108-132	188-212	85-105
303	7100	single circuit , single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
308'	14400	single circuit , single pole or H-frame	PL, most	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
310**	13700	double circuit, single pole	TL	6-5	20	120	125-135
Total	614500						

*TL=Transmission Line, RR=Railroad, R=Road, PL=Pipeline

**This segment would not be needed if the selected Oliver sector route uses segment 311.

Owen 3 Route

This route was developed by Commission staff in an effort to maximize the use of existing corridors. More than half of the 117.5-mile route would follow existing facility corridors (petroleum pipeline, electric transmission line, or railroad). The route is identical to the Owen 2 Route from Exeland to south of Owen. Between Owen and Abbotsford the Owen 3 Route follows an existing electric transmission line corridor from which a portion of the existing transmission line is to be removed. In Commission docket 05-CE-107, the Baldwin to Marathon City transmission line project, the Commission ordered that much of the existing 115 kV transmission line in this corridor be relocated and double circuited with a NSP 69 kV line about one to two miles further south. Between Abbotsford and Edgar, the route follows a recently rebuilt electric transmission line. The route then continues east, cross-country, to the Weston Substation. A relatively short distance of existing electric transmission line would be double circuited leading into the plant site.

Where the route is adjacent to electric transmission lines, the new line could be built as a double circuit line, or built parallel to the existing line on either H-frame or single pole structures. Up to 40 feet of additional ROW would be required for double circuit construction, and up to 115 feet for parallel construction. Where the route is adjacent to a railroad, pipeline, or road, the new line would be built parallel to the existing corridor and would require between 91 and 132 additional feet of ROW.

Tables 6-13 and 6-14 list all of the segments comprising the Owen 3 Route as proposed and other information about the physical appearance of each segment.

Table 6-13 Owen 3 Route (double circuit)

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
1a	11300	double circuit, single pole	TL	6-19	0	190	125-135
1b	4500	double circuit, single pole	TL	6-19	0	190	125-135
7a	4400	single circuit, single pole or H-frame	PL, R	6-10 or NA	108-132	208-232	85-105
7b	1000	single circuit, single pole or H-frame	PL, R	6-10 or NA	108-132	208-232	85-105
14a	4300	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
14b	55600	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
19	900	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
21	16200	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
23a	16900	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
23b	7200	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
202a	7100	double circuit, single pole-partial single circuit, single pole or H-frame-partial	TL-partial	6-17 or 6-18 and 6-5	40-150	120-150	85-135
202c	34900	double circuit, single pole	TL	6-5	40	120	125-135
204	4700	double circuit, single pole	TL	6-5	40	120	125-135
205	7100	double circuit, single pole	Road-partial	6-19 and NA	91-120	120-157	125-135
207	72100	double circuit, single pole-partial single circuit, single pole or H-frame-partial	TL	6-17 or 6-18 and 6-5	30-60	120-150	85-135
211	4900	single circuit, single pole or H-frame	TL	6-5	30-60	120-150	85-105
213'	42500	double circuit, single pole-partial single circuit, single pole or H-frame-partial	TL, partial	6-17 or 6-18, and 6-5	30-60	120-150	85-135
223	33500	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
226	16800	single circuit, single pole or H-frame	PL	6-10 or 6-11	108-132	188-212	85-105
229	20600	single circuit, single pole or H-frame	PL, most	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
230	2500	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
231	9800	single circuit, single pole or H-frame	RR	6-12 or 6-13	98-122	198-222	85-105
233	2500	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
235	23900	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
237	48400	single circuit, single pole or H-frame	PL, most	6-10 or 6-11	108-150	120-212	85-105
239	31800	single circuit, single pole or H-frame	PL-partial	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
240	5800	single circuit, single pole or H-frame	PL-partial	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
242'	83100	double circuit, single pole-partial single circuit, single pole or H-frame-partial	TL-partial PL-partial	6-10 or 6-11, and 6-17 or 618,and NA	108-150	120-212	85-135
301a'	7900	single circuit, single pole or H-frame	PL	6-10 or 6-11	108-132	188-212	85-105
301b	2900	single circuit, single pole or H-frame	PL	6-10 or 6-11	108-132	188-212	85-105
303	7100	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
308'	14400	single circuit, single pole or H-frame	PL-partial	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
310**	13700	double circuit, single pole	TL	6-5	20	120	125-135
Total	620300						

*TL=Transmission Line, RR=Railroad, R=Road, PL=Pipeline

**This segment would not be needed if the selected Oliver sector route uses segment 311.

Table 6-14 Owen 3 Route (parallel)

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
1a	11300	double circuit, single pole	TL	6-19	0	190	125-135
1b	4500	double circuit, single pole	TL	6-19	0	190	125-135
7a	4400	single circuit, single pole or H-frame	PL, R	6-10 or NA	108-132	208-232	85-105
7b	1000	single circuit, single pole or H-frame	PL, R	6-10 or NA	108-132	208-232	85-105
14a	4300	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
14b	55600	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
19	900	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
21	16200	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
23a	16900	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
23b	7200	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
202a	7100	single circuit, single pole or H-frame	TL-partial	6-17 or 6-18, and 6-8 or 6-9	90-150	120-195	85-105
202c	34900	single circuit, single pole or H-frame	TL	6-8 or 6-9	90-115	170-195	85-105
204	4700	single circuit, single pole or H-frame	TL	6-8 or 6-9	90-115	170-195	85-105
205	7100	double circuit, single pole	R, partial	6-19 and NA	91-120	120-157	125-135
207	72100	single circuit, single pole or H-frame	TL	6-17 or 6-18	30-115	120-205	85-105
211	4900	single circuit, single pole or H-frame	TL	6-17 or 6-18	30-60	120-150	85-105
213'	42500	double circuit, single pole-partial single circuit, single pole or H-frame-partial	TL-partial	6-17 or 6-18, and 6-5	30-110	120-200	85-135
223	33500	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
226	16800	single circuit, single pole or H-frame	PL	6-10 or 6-11	108-132	188-212	85-105
229	20600	single circuit, single pole or H-frame	PL, most	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
230	2500	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
231	9800	single circuit, single pole or H-frame	RR	6-12 or 6-13	98-122	198-222	85-105

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
233	2500	Single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
235	23900	Single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
237	48400	Single circuit, single pole or H-frame	PL, most	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
239	31800	Single circuit, single pole or H-frame	PL-partial	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
240	5800	Single circuit, single pole or H-frame	PL-partial	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
242'	83100	double circuit, single pole-partial single circuit, single pole or H-frame-partial	TL-partial PL-partial	6-10 or 6-11, and 6-17 or 6-18, and NA	108-150	120-212	85-135
301a'	7900	Single circuit, single pole or H-frame	PL	6-10 or 6-11	108-132	188-212	85-105
301b	2900	Single circuit, single pole or H-frame	PL	6-10 or 6-11	108-132	188-212	85-105
303	7100	Single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
308'	14400	Single circuit, single pole or H-frame	PL-partial	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
310**	13700	Single circuit, single pole or H-frame	TL	6-5	90-115	180-205	85-105
Total	620300						

*TL=Transmission Line, RR=Railroad, R=Road, PL=Pipeline

**This segment would not be needed if the selected Oliver sector route uses segment 311

Owen 4 Route

This route was developed by Commission staff in an effort to maximize the use of existing corridors and to further reduce impacts to OERW. More than half of the total length of the route (118.4 miles) would follow existing facility corridors (petroleum pipeline, electric transmission line, or railroad). The route is identical to the Owen 2 Route from Exeland to south of Owen. Between Owen and Abbotsford the Owen 4 Route follows an existing electric transmission line corridor from which a portion of the existing transmission line is to be removed. In Commission docket 05-CE-107, the Baldwin to Marathon City transmission line project, the Commission ordered that much of the existing 115 kV transmission line in this corridor be relocated and double circuited with an NSP 69 kV line about one to two miles further south. Between Abbotsford and Edgar, the route follows a recently rebuilt electric transmission line. The route then continues east, cross-country, to the Weston Substation. A relatively short distance of existing electric transmission line would be double circuited leading into the plant site.

Where the route is adjacent to electric transmission lines, the new line could be built as a double circuit line, or built parallel to the existing line on either H-frame or single pole structures. Up to 40 feet of additional ROW would be required for double circuit construction, and 85 to 115 feet for parallel construction. Where the route is adjacent to a railroad, pipeline, or road, the new line would be built parallel to the existing corridor and would require between 91 and 132 additional feet of ROW.

Tables 6-15 and 6-16 list all of the segments comprising the Owen 4 Route as proposed and other information about the physical appearance of each segment.

Table 6-15 Owen 4 Route (double circuit)

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
1a	11300	double circuit, single pole	TL	6-19	0	190	125-135
1b	4500	double circuit, single pole	TL	6-19	0	190	125-135
8a	3100	double circuit, single pole	TL	6-19	0	190	125-135
8b	2000	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
11	46300	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
16	18400	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
18	1500	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
21	16200	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
23a	16900	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
23b	7200	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
202a	7100	double circuit, single pole-partial single circuit, single pole or H-frame-partial	TL-partial	6-17 or 6-18 and 6-5	40-150	120-150	85-135
202c	34900	double circuit, single pole	TL	6-5	40	120	125-135
204	4700	double circuit, single pole	TL	6-5	40	120	125-135
205	7100	double circuit, single pole	Road-partial	6-19 and NA	91-120	120-157	125-135
207	72100	double circuit, single pole-partial single circuit, single pole or H-frame-partial	TL	6-5	30-60	120-150	85-135
211	4900	single circuit, single pole or H-frame	TL	6-5	30-60	120-150	85-105

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
213'	42500	double circuit, single pole-partial single circuit, single pole or H-frame-partial	TL, partial	6-17 or 6-18, and 6-5	30-60	120-150	85-135
223	33500	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
226	16800	single circuit, single pole or H-frame	PL	6-10 or 6-11	108-132	188-212	85-105
229	20600	single circuit, single pole or H-frame	PL, most	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
230	2500	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
231	9800	single circuit, single pole or H-frame	RR	6-12 or 6-13	98-122	198-222	85-105
233	2500	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
235	23900	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
237	48400	single circuit, single pole or H-frame	PL, most	6-10 or 6-11	108-150	120-212	85-105
239	31800	single circuit, single pole or H-frame	PL-partial	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
240	5800	single circuit, single pole or H-frame	PL-partial	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
242'	83100	double circuit, single pole-partial single circuit, single pole or H-frame-partial	TL-partial PL-partial	6-10 or 6-11, and 6-17 or 6-18, and NA	108-150	120-212	85-135
301a'	7900	single circuit, single pole or H-frame	PL	6-10 or 6-11	108-132	188-212	85-105
301b	2900	single circuit, single pole or H-frame	PL	6-10 or 6-11	108-132	188-212	85-105
303	7100	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
308'	14400	single circuit, single pole or H-frame	PL-partial	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
310**	13700	double circuit, single pole	TL	6-5	20	120	125-135
Total	625400						

*TL=Transmission Line, RR=Railroad, R=Road, PL=Pipeline

**This segment would not be needed if the selected Oliver sector route uses segment 311.

Table 6-16 Owen 4 Route (parallel)

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
1a	11300	double circuit, single pole	TL	6-19	0	190	125-135
1b	4500	double circuit, single pole	TL	6-19	0	190	125-135
8a	3100	double circuit, single pole	TL	6-19	0	190	125-135
8b	2000	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
11	46300	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
16	18400	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
18	1500	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
21	16200	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
23a	16900	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
23b	7200	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
202a	7100	single circuit, single pole or H-frame	TL-partial	6-17 or 6-18, and 6-8 or 6-9	90-150	120-195	85-105
202c	34900	single circuit, single pole or H-frame	TL	6-8 or 6-9	90-115	170-195	85-105
204	4700	single circuit, single pole or H-frame	TL	6-8 or 6-9	90-115	170-195	85-105
205	7100	double circuit, single pole	R, partial	6-19 and NA	91-120	120-157	125-135
207	72100	single circuit, single pole or H-frame	TL	6-17 or 6-18	30-115	120-205	85-105
211	4900	single circuit, single pole or H-frame	TL	6-17 or 6-18	30-60	120-150	85-105
213'	42500	double circuit, single pole-partial single circuit, single pole or H-frame-partial	TL-partial	6-17 or 6-18, and 6-5	30-110	120-200	85-135
223	33500	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
226	16800	single circuit, single pole or H-frame	PL	6-10 or 6-11	108-132	188-212	85-105
229	20600	single circuit, single pole or H-frame	PL, most	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
230	2500	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
231	9800	single circuit, single pole or H-frame	RR	6-12 or 6-13	98-122	198-222	85-105

Segment Number	Length Feet	Line Design	Other Facilities at Location*	Figure Number	New ROW Width (feet)	Total ROW Width (feet)	Pole Height/feet
233	2500	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
235	23900	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
237	48400	single circuit, single pole or H-frame	PL, most	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
239	31800	single circuit, single pole or H-frame	PL-partial	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
240	5800	single circuit, single pole or H-frame	PL-partial	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
242'	83100	double circuit, single pole-partial, single circuit, single pole or H-frame-partial	TL-partial PL-partial	6-10 or 6-11, and 6-17 or 6-18, and NA	108-150	120-212	85-135
301a'	7900	single circuit, single pole or H-frame	PL	6-10 or 6-11	108-132	188-212	85-105
301b	2900	single circuit, single pole or H-frame	PL	6-10 or 6-11	108-132	188-212	85-105
303	7100	single circuit, single pole or H-frame	None	6-17 or 6-18	120-150	120-150	85-105
308'	14400	single circuit, single pole or H-frame	PL-partial	6-10 or 6-11, and 6-17 or 6-18	108-150	120-212	85-105
310**	13700	single circuit, single pole or H-frame	TL	6-5	90-115	180-205	85-105
Total	606600						

*TL=Transmission Line, RR=Railroad, R=Road, PL=Pipeline

**This segment would not be needed if the selected Oliver sector route uses segment 311

The Rhinelander Sector

As mentioned previously in this chapter, this sector is further divided into two subsectors, each containing three route alternatives. The routes in the western subsector (west of USH 51) could be connected to any of the three routes in the eastern subsector (east of USH 51) using one or more segments that parallel USH 51. A brief description of the routes and the proposed line design is found below. More detailed maps of the routes and a description of the route-specific environmental impacts are in Chapter 11. Tables similar to those presented above are provided in Chapter 11.

Western Subsector (west of USH 51)

The western subsector contains three routes. Each of the routes begins at CTH YY and proceeds in a general easterly direction to USH 51.

North Route

This route, 19.8 miles long, begins at the intersection of USH 8 and CTH YY. It follows the USH 8 corridor and a railroad corridor parallel to USH 8 for about 11 miles before turning north for several miles. South of Killarney Lake, the North Route proceeds east again to USH 51 passing about two miles north of Heafford Junction. The new line would be built on single circuit davit structures and would require 43 to 80 feet of new ROW, depending on whether the line is adjacent to a road or the railroad.

Central Route

This route, 19.0 miles long, begins at the intersection of USH 8 and CTH YY. It largely follows the same corridors as the North Route, except that it continues east along the USH 8 to USH 51. The new line would be built on single circuit davit structures and would require 43 to 80 feet of new ROW, depending on whether the line is adjacent to a road or the railroad.

South Route

This route, 17.7 miles long, begins at Substation Site 1 and proceeds east cross-country toward the Somo Dam. East of the dam, the route follows several narrow town roads and CTH CC into the north end of the city of Tomahawk. The route continues east, parallel to CTH A, to USH 51. The new line would be built on single circuit davit arm structures and would require 80 feet of new ROW through areas where it runs cross-country and about 43 feet of new ROW where it parallels roads.

Eastern Subsector (east of USH 51)

The three routes in this subsector begin at USH 51 and proceed east to the Highway 8 Substation in Rhinelander.

Railroad Route

This route, 17.0 miles long, begins at USH 51 about 2 miles north of USH 8 and follows a railroad corridor for several miles. It then angles southeast across USH 8 and follows a series of town roads and a portion of a pipeline corridor as it proceeds east across the Wisconsin River. About one mile east of the river, the route intersects with an existing 115 kV transmission line corridor and follows this ROW north about four miles to the substation in Rhinelander. The new line would be double circuited with this portion of the existing line and would require little or no new ROW. Between USH 51 and the existing transmission line, the new line would be built on single circuit davit structures and would require 43 to 80 feet of new ROW.

Highway 8 Route

This route, 16.3 miles long, begins at the intersection of USH 8 and USH 51 and follows USH 8 east for several miles. It then continues east along a series of town roads and a portion of a pipeline corridor across the Wisconsin River to an existing transmission line ROW. The route follows the existing transmission line ROW north to the substation in Rhinelander. The new line would be double circuited with this portion of the existing line and would require little or no new ROW. Between USH 51 and the existing transmission line, the new line would be built on single circuit davit structures and would require 43 to 80 feet of new ROW.

Cross-Country Route

This route, 17.6 miles long, begins at the intersection of USH 8 and CTH A. It proceeds due east along CTH A for four miles and then continues cross-country to an existing transmission line corridor west of Perch Lake. The route follows the existing transmission line northeast and north to the substation in Rhinelander. Parallel construction is proposed for the southern portion of the existing transmission line corridor. This portion of the route and the cross-country sections would require 80 feet of new ROW. Other sections of the route parallel to CTH A would require about 43 feet of additional ROW. No new ROW would be needed for the portion north of Hat Rapids Road to the substation in Rhinelander.

Proposed structures and ROW widths

The following pages contain diagrams showing the new 345 kV transmission line built within or adjacent to the ROWs of existing infrastructure. These diagrams show the width of the existing ROW and the additional ROW needed to accommodate the 345 kV transmission line. Detailed diagrams of the proposed structures follow the ROW diagrams.

Figure 6-5 Double circuit 345 kV on existing transmission line ROW

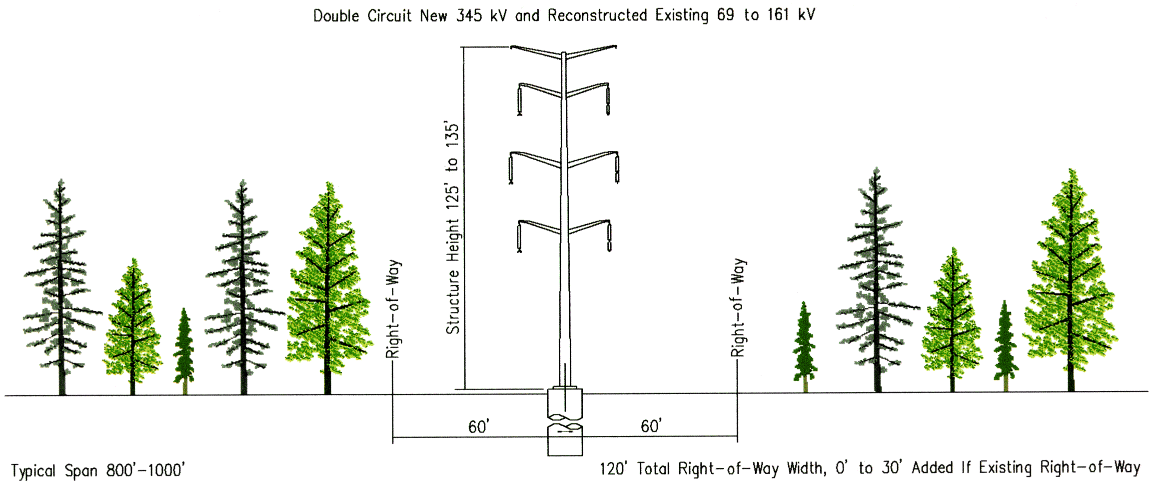


Figure 6-6 Single circuit 345 kV H-frame parallel to existing H-frame transmission line

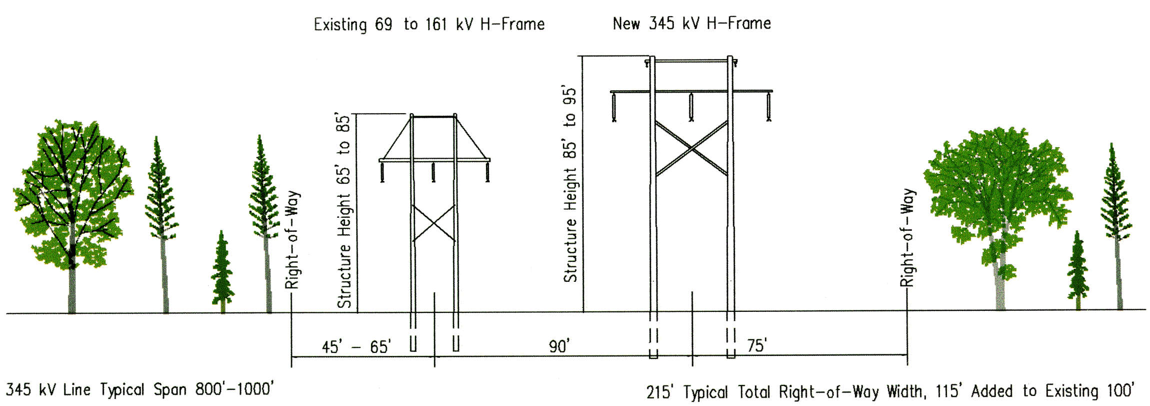


Figure 6-7 Single circuit 345 kV single pole parallel to existing H-frame transmission line

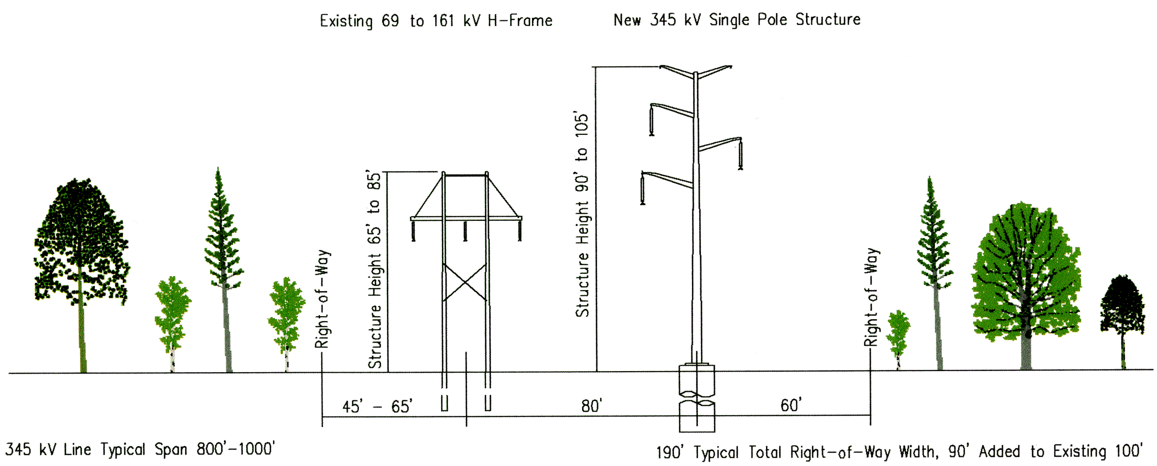


Figure 6-8 Single circuit 345 kV H-frame parallel to existing single pole transmission line

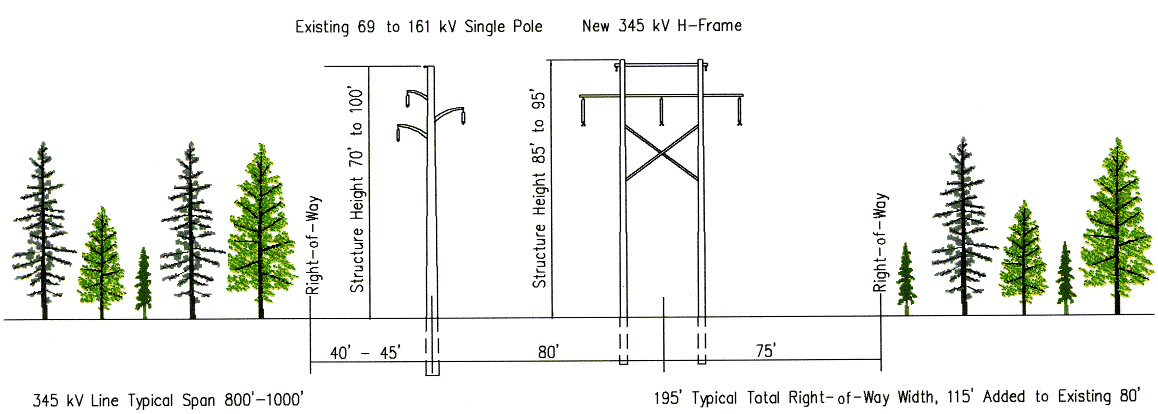


Figure 6-9 Single circuit 345 kV single pole parallel to existing single pole transmission line

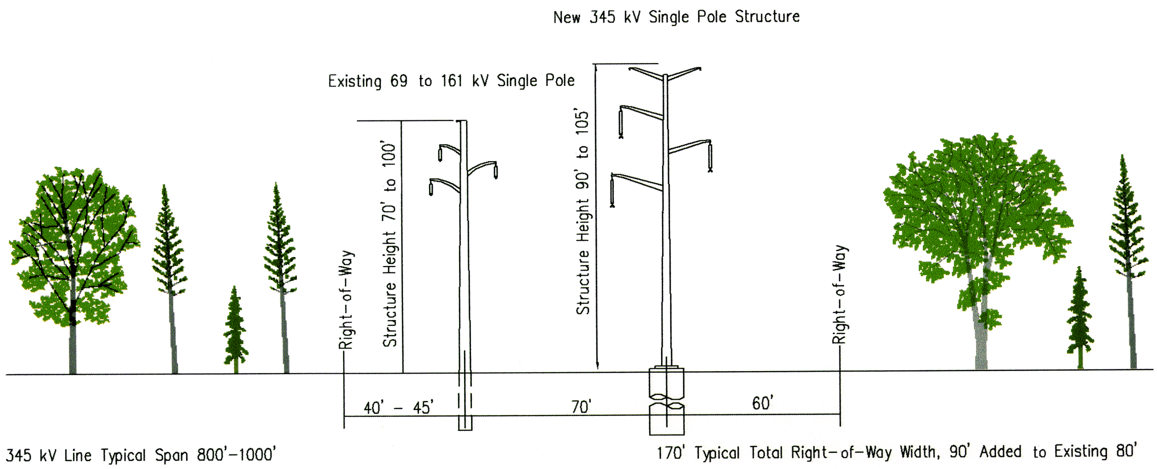


Figure 6-10 Single circuit 345 kV H-frame parallel to pipeline

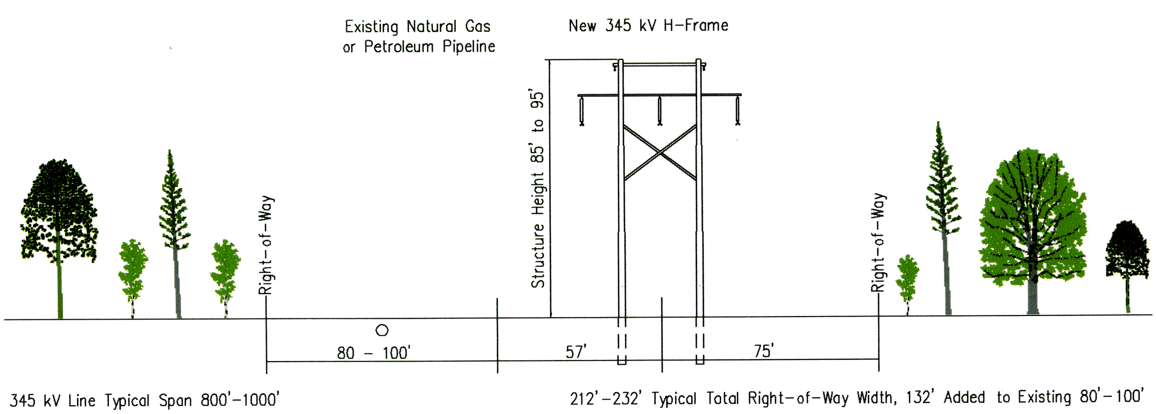


Figure 6-11 Single circuit 345 kV single pole parallel to pipeline

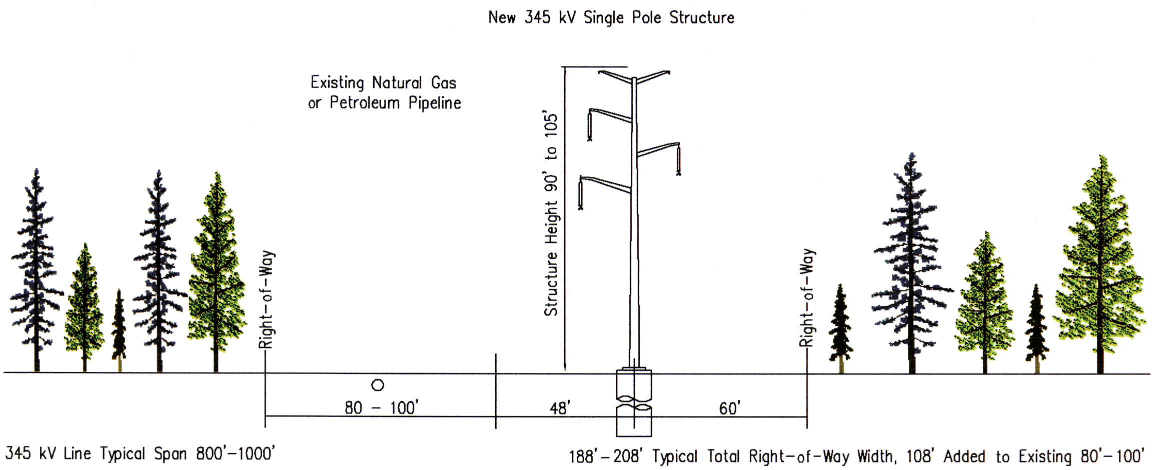


Figure 6-12 Single circuit 345 kV H-frame parallel to railroad

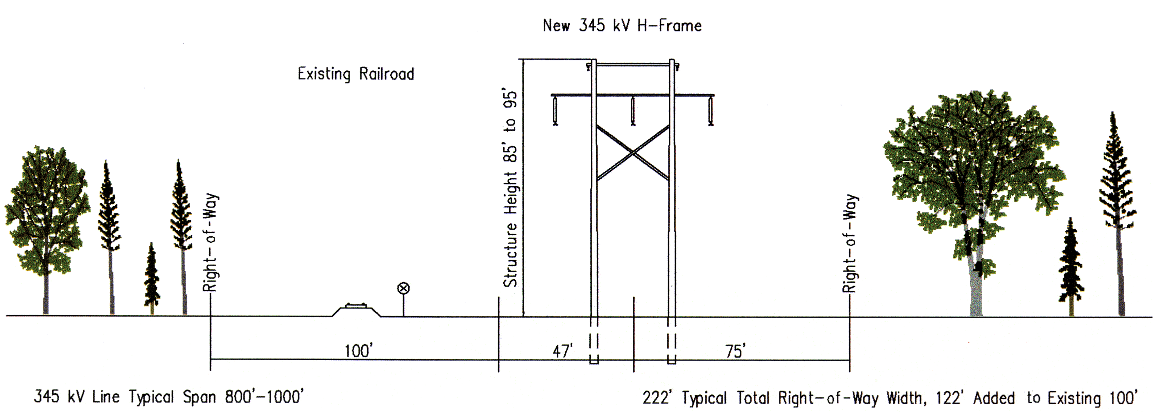


Figure 6-13 Single circuit 345 kV single pole parallel to railroad

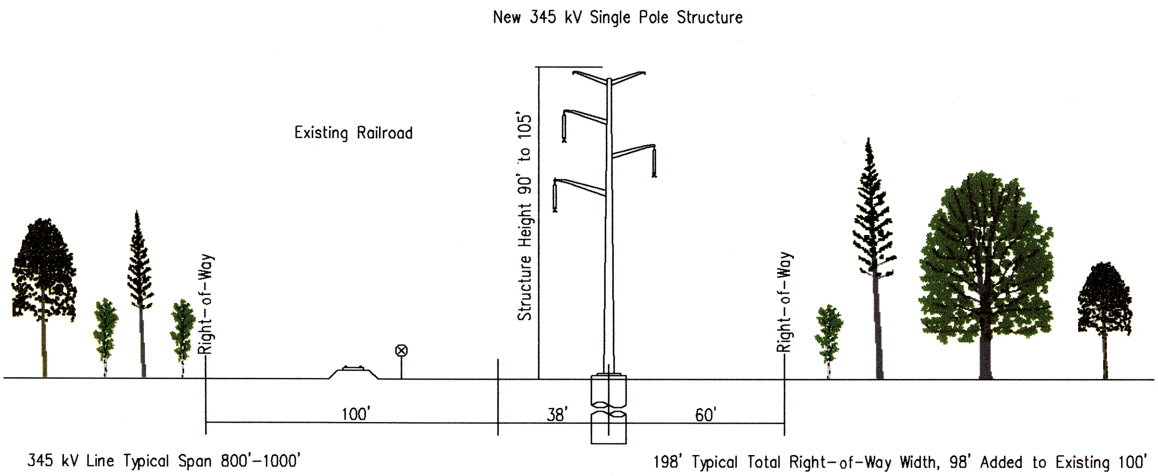


Figure 6-14 Single circuit 345 kV H-frame parallel to roadway

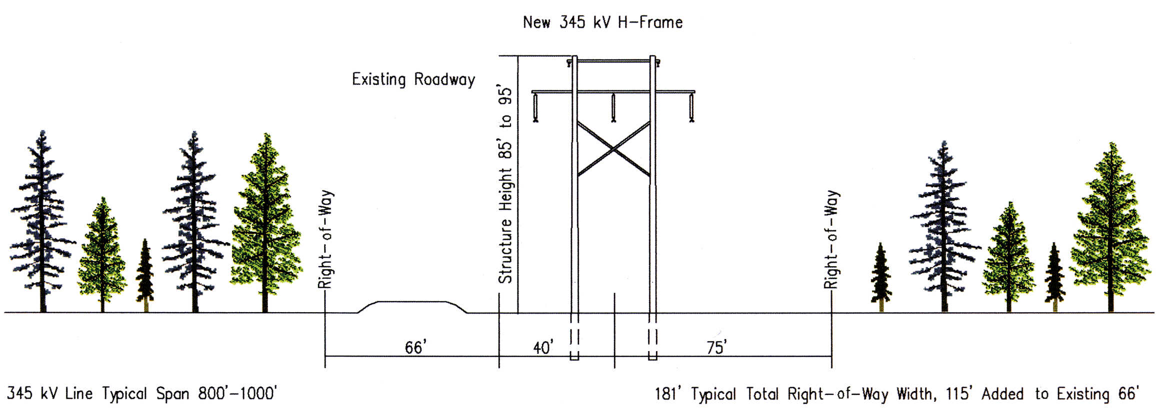


Figure 6-15 Single circuit 345 kV single pole parallel to roadway

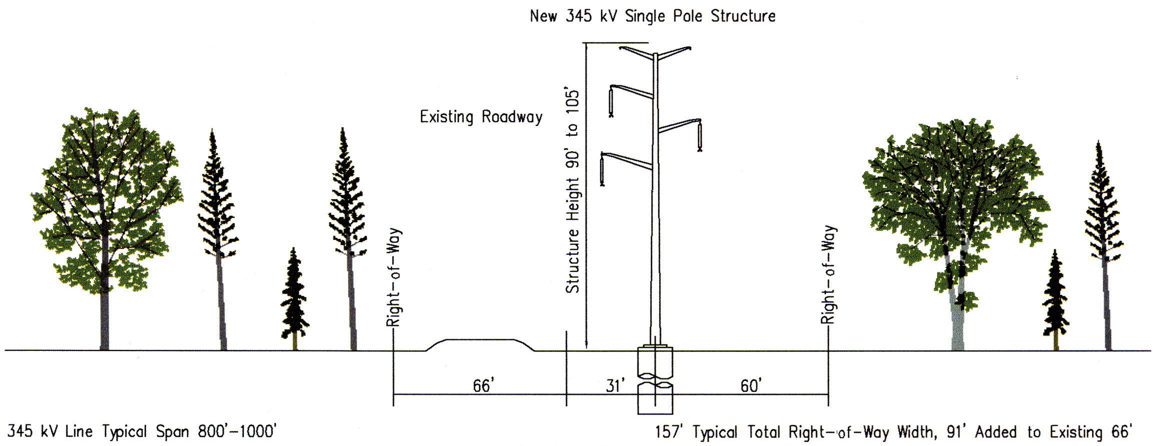


Figure 6-16 Single circuit 345 kV H-frame parallel to railroad and existing H-frame transmission line

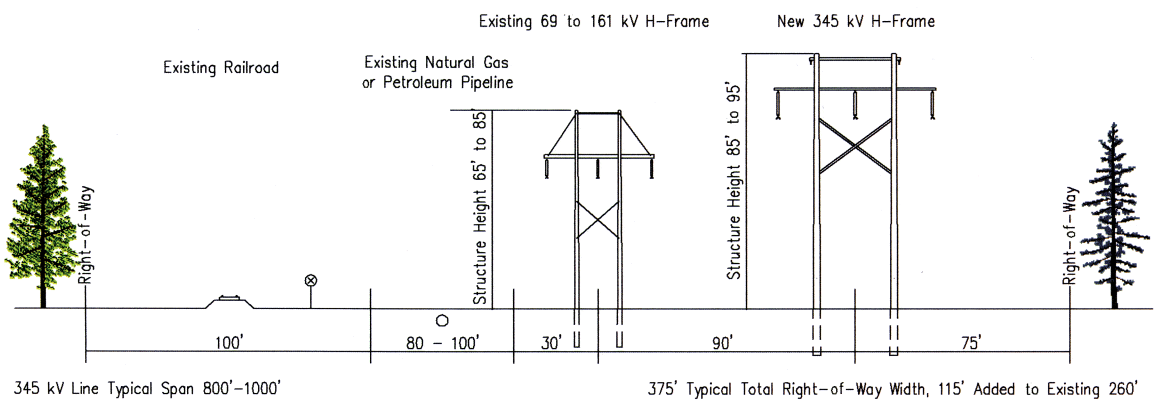


Figure 6-17 345 kV single circuit H-frame

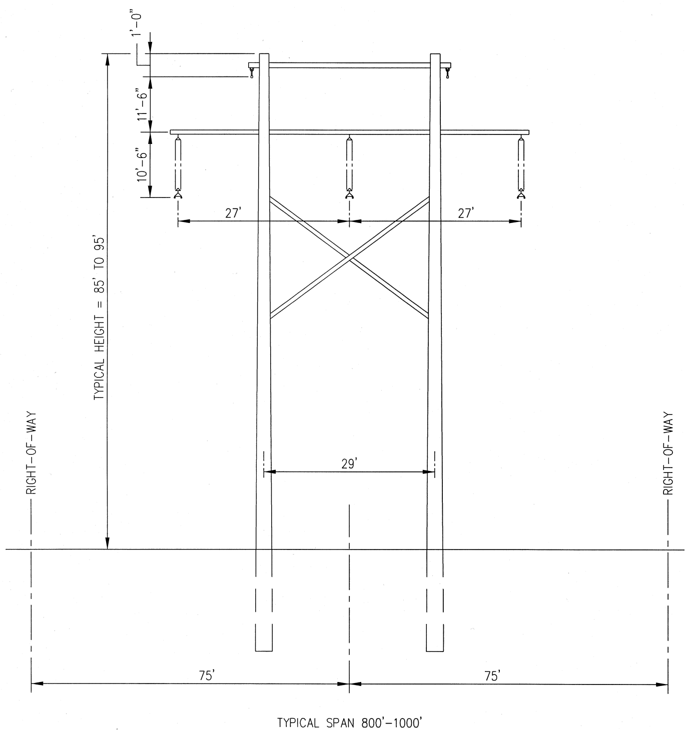


Figure 6-18 345 kV single circuit single pole

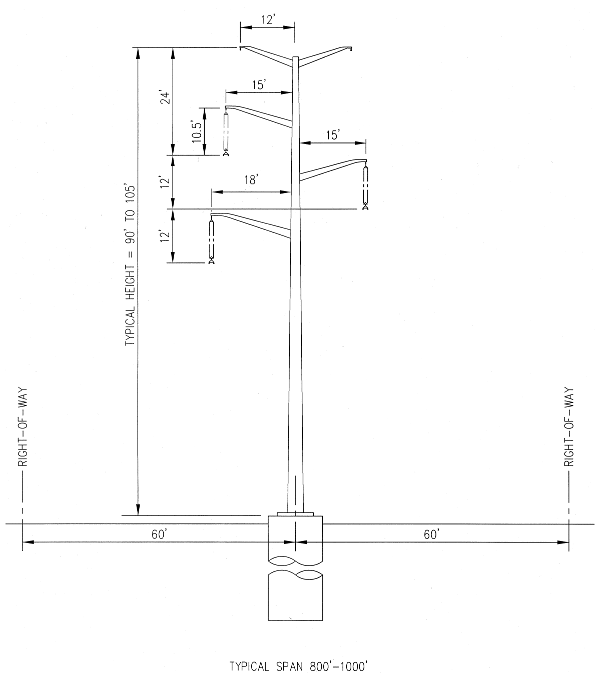


Figure 6-19 Double circuit 345 kV with 69 kV or 115 kV or 161 kV or 345 kV single pole

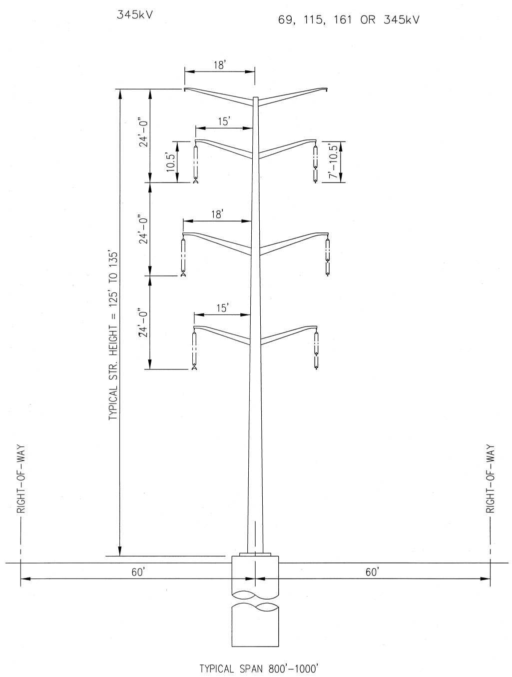
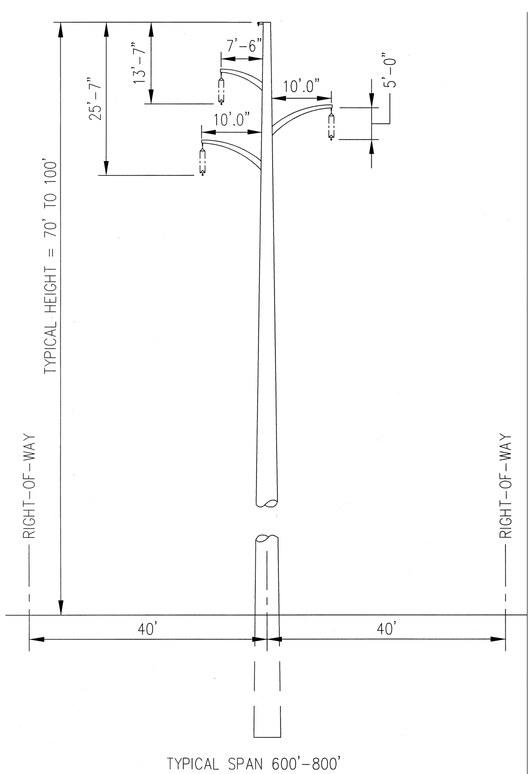


Figure 6-20 115 kV single circuit single pole



Transmission Line Construction Practices and Mitigation

Construction and environmental mitigation practices can take on a variety of forms. These practices can be loosely grouped as Best Management Practices (BMPs). BMPs can be defined as "effective, feasible (including technological, economic and institutional considerations) conservation practices and land and water management measures that avoid or minimize adverse impacts to the chemical, physical, or biological characteristics of a natural resource."[180] These practices may include schedules for activities, prohibitions, maintenance guidelines, inspection procedures, and other practices. For example, in the case of wetlands such practices include avoiding wetlands, controlling soil loss, reducing water quality degradation, and minimizing the impacts on hydrologically connected surface and groundwater and on the plants and animals that the water supports.

Some portions of the Arrowhead-Weston project involve constructing a transmission line through a remote landscape that includes large tracts of unbroken forest and large wetlands. Some of the obvious construction challenges and limitations would include gaining access to these areas with heavy construction equipment and moving equipment within and through wetlands, and across streams and intermittent water channels. There could also be limitations related to constructing a transmission line through wetlands and sandy uplands that include weak or unstable soil conditions or a fragile community of native flora and fauna.

In addition to commonly accepted construction techniques for erecting power poles and stringing power lines, special techniques have been developed by the utility industry to adapt to unfavorable conditions encountered in the wetland environment. The applicants were asked to provide a description of some of the specific construction practices that might be needed if the Arrowhead-Weston project is approved. The construction practices and techniques described by the applicants are similar to those used in a project in the Upper Peninsula of Michigan and are described in detail in the following sections.

WEPCO built a transmission line project in the Upper Peninsula of Michigan (Commission docket 6630-CE-245) that encountered terrain and challenges similar to those present along some of the proposed routes for the Arrowhead-Weston Project. The WEPCO project involved the construction of a 138 kV transmission line from Perkins to Manistique, passing through 21 miles of the Hiawatha National Forest, which is managed by the U.S. Forest Service (USFS). An EIS for the project was prepared by the USFS. A detailed Construction Plan and Environmental Information Manual, describing practices that addressed physical construction of the line and mitigation to minimize impacts in the wetland ROW and adjacent landscape, were

[180] Peale, M. 1996. Best Management Practices for Wetlands within Colorado State Parks. Colorado Natural Areas Program, Colorado State Parks, Colorado Department of Natural Resources. Denver, Colorado.

developed from information in the EIS.[181] The applicants have indicated that the same construction company and many of the same construction practices may be used to build the Arrowhead-Weston Transmission Project. Photographs illustrating the Upper Peninsula construction and mitigation techniques are referenced in the discussion below and shown in Volume 2. (See Figures 2-35 through 2-46.)

Projected costs that could be incurred from implementing these specialized construction and wetland mitigation measures can be found in the "Project Costs" section later in this chapter.

General construction methods

Construction methods for building a transmission line need to address installation of temporary or permanent access roads and land and water bridges, vegetative clearing of access roads and ROW areas, drilling holes for power pole foundations, setting poles, and stringing wire. Each of these items is briefly discussed below.

- Vehicle access and travel in the ROW Construction of new access roads should be limited. Where necessary, such roads should be sited to minimize wetland loss and fill, i.e. on dunes or upland areas within the wetland. Additionally, roads should be built without shoulders to allow free passage of both surface water and shallow groundwater. Roads are sometimes left as permanent access for routine line maintenance but most should be completely removed post-project. Alternatively, hardwood timber mats could be used to construct temporary roads between pole locations and construction site pads at pole sites within wetlands. These mats could also be used to construct bridges to span streams, intermittent streams, and other irregularities in the landscape that would impede vehicle traffic.
- Typical mats are 3 to 4 feet wide and 18 to 20 feet long. They are constructed of 8 to 12 inch square hardwood timbers fastened together. (On the Perkins-Manistique project, it took approximately 400 mats to build an access road between poles and another 300 to build a construction pad at the pole location.) The construction mats are assembled, disassembled, and moved to new construction sites during the project. These mats must bear the weight of heavy equipment such as cranes and cement trucks. They can be used approximately 10 times before they become too damaged and are discarded. Due to the effort involved in the construction of the mats on the Upper Peninsula project, a mat access road was built to connect three pole locations at once and work proceeded on two pole locations simultaneously when possible. (Figures Vol. 2-35, 2-36 and 2-37).

[181] USDA Forest Service. Perkins-Manistique 138 kV Transmission Line EIS. Record of Decision and Final Environmental Impact Statement. Hiawatha National Forest, Michigan. December 1998.

Helicopters are sometimes used to transport and set transmission line poles in difficult to access locations, such as mountainous terrain or extremely steep slopes. They were considered for use on the Upper Peninsula project to alleviate extensive tracking of heavy equipment in and out of the wetland areas, but proved to be a cost-prohibitive option and still required ground access into the wetlands.

- **ROW clearing** Large tree and woody shrub clearing in the ROW could be accomplished using a combination of mechanized and hand techniques. Timber harvesting machinery could be employed to clear large trees in areas where rutting or soil compaction are not expected. (See Figure Vol. 2-38.) Hand clearing with chainsaws and other hand tools should be used in especially sensitive areas. Typically, vegetation over 15 feet in height would be removed to ground level (approximately 3 inches above ground surface) in the ROW. Merchantable trees, non-merchantable trees and timber slash could be handled in a variety of ways that include timber sale, leaving it lay in place, chipping or off-site removal. Stump removal and grading should be restricted to pole construction work areas and potential safety hazards.
- **Pole foundation construction** Where potential limitations of wetland soils and sand are encountered, pole foundations would likely be drilled and constructed using specialized methods and equipment. Depending on the pole design (tangent structure, light angle, heavy angle or dead end structure), foundation construction could range from directly embedding poles (backfilled with concrete, gravel or native material if acceptable) to excavating large holes and pouring concrete foundations on which the poles can be fastened. Poured foundations in the Upper Peninsula required drilled-caisson methods. Because the wetland soils lacked necessary physical structure, steel casing was installed around each foundation location to the depth of the foundation to prevent the foundation hole from collapsing during drilling. Holes were drilled inside the casing and a reinforced steel cage and anchor bolt cage were installed and set in concrete (casings were removed after the concrete set unless an extensive bed of peat existed that required the casing to remain as a permanent structure). (See Figures Vol. 2-39 and Vol. 2-40.) Spoils from drilling of foundation holes were taken off site and spread in upland areas.

Typical foundations on the Upper Peninsula project ranged from 17 to 27 feet in depth and 6 to 8 feet in diameter. However, foundation size is a function of soil conditions and pole structure and can range from 4 to 12 feet in diameter and 20 to 50 feet in depth. Specific cement composition and pouring techniques were employed to displace water that was introduced from the surrounding water table. When dewatering was necessary in some foundation holes, the water was discharged outside of the wetland or through bag filters to remove solids and prevent wetland contamination.

- **Pole construction and wire stringing** In the Upper Peninsula project, power poles were constructed in two pieces because access was difficult and equipment availability varied. Many of the access roads did not provide enough turning radius for trucks to bring poles into the area in one piece. The base of a pole was installed on the foundation, and then the top was added. This practice made it possible to use lighter duty equipment to set the pole base and call larger cranes and equipment into duty when the tops were placed. Transmission line stringing also had to be adapted in wetland conditions. Where practicable, stringing or pulling sites were located on dry land at least 50 feet from a wetland edge. (See Figures Vol. 2-41 and Vol. 2-42.)

Wetland mitigation

Performing large-scale construction projects in a fragile landscape, such as a wetland, requires extra care in minimizing physical and biological impacts. In addition to the construction site BMPs required by the DNR, several site-specific mitigation measures that were imposed on the Upper Peninsula transmission line project by the Hiawatha National Forest management could be adapted to the current project if approved. Methods such as hand clearing vegetation, low-impact (rubber track) vehicles, and operating heavy equipment from mats are commonly used methods to protect wetlands.[182] Securing relevant state and federal permits to work in wetlands would further protect the integrity of the wetland resources. Some potential site-specific mitigation practices for wetlands are briefly discussed below:

- **Timing and use of hardwood matting** Entering and working in wetlands is easier and less damaging during frozen conditions. Using existing snow pack and ice formation enables the creation of ice roads within a wetland. Traveling on ice roads allows vehicles and equipment to travel on top of the vegetation without crushing it or creating ruts. Although frozen conditions are preferred, recent winters have proven unpredictable and frozen conditions may not be consistent throughout the winter season. (Frozen conditions were not always prevalent during construction in the Upper Peninsula.) To overcome this situation, hardwood mats could be used extensively as roads, construction pads and bridges throughout the wetland areas. (See Figure Vol. 2-43.) These mats, in combination with avoiding extremely wet conditions, help reduce rutting in wetlands. All matting materials should be removed after completing construction.
- **ROW clearing** Clearing trees and woody vegetation in a wetland requires special attention in preserving the natural root and seed stocks that are nested in the topsoil. These are the resources that allow wetland vegetation to restore itself naturally. As discussed in a prior section, trees and shrubs greater than 15 feet in height would be cut to the ground in the ROW. Excavated soils, except topsoil, should be disposed of off-site in upland areas and the topsoil should be returned to its original location. A feathering technique used for the Upper Peninsula project ROW mitigated the abruptness of the forest-ROW edge. Feathering was done by prescribing that a certain percentage of tree and shrub cover be taken at specified distances from the

[182] Breece, G.A., and B.J. Ward. 1996. Utility Biodiversity Issues. Env. Mngmt. 20(6), 799-803.

edge of the ROW, i.e. 80 percent clearing within the first 20 feet, 60 percent within the next 30 feet, up to 30 percent in the next 50 feet. (See Figure Vol. 2-44.)

- **Erosion control** Instituting erosion control in and around wetlands is paramount to protecting these delicate resources from sedimentation and water quality impacts. In addition to adhering to the DNR construction site BMPs, COE permits and DNR permits would also stipulate how to implement erosion control practices. Using rubber tire and tracked equipment, avoiding extremely wet conditions, and prohibiting activities that cause ruts greater than 12 inches would add to the success of other preventative measures.
- Site restoration Excepting the original tree and woody vegetation height in the wetland ROW, construction sites should be returned to their natural character. This should include, but is not limited to, removing temporary access roads and bridges and refurbishing vegetation. Re-vegetating wetlands should be accomplished through natural regeneration and replanting trees, shrubs and other woody vegetation with native stock found in and around the wetland areas. (See Figure Vol. 2-45.) Additionally, as with the Upper Peninsula project, an annual monitoring plan should be written for a specified number of years following the project to ensure the wetlands and the vegetation are returning to their natural form.
- **Miscellaneous mitigation measures** Several other measures were taken in the Upper Peninsula project to help reduce adverse impacts to the Hiawatha National Forest wetlands and streams. First, an independent on-site inspector was contracted for the Upper Peninsula project to inspect the wetland construction activities along the 21-mile project on a daily basis. This was an integral part of protecting the integrity of the wetlands and was an excellent method of tracking the wetland response to invasive construction practices. Second, special attention was also paid to control noxious or invasive weeds in and around the wetlands. Truck washing stations were set up to wash vehicles before entering wetlands in order to prevent the transport of invasive species into the wetlands and enable their establishment. (See Figure Vol. 2-46.) Finally, an effort was made to mitigate impacts from fuel spills or blown equipment lines. Some of the equipment used to install the foundation casing used vegetable oil (biodegradable) rather than hydraulic oil in the lines to reduce the harmful effects of spills in the wetland.

Project Costs

The costs for each route vary depending on many factors. These factors include: the total length of the route, the line design (double circuit or parallel construction) in places where the route follows an existing transmission line, the length of the new line that would require new ROW, and the pole types used. In the table below, it is assumed that all of the routes include some portion that would be single circuit (on new ROW or adjacent to a road, pipeline or railroad). The line designs listed for each route apply to those sections of the route that follow an existing transmission line. The cost estimate for underground construction of the 345 kV line include boring the line under the Namekagon River and construction of the associated transition stations (see Chapter 7 for a more detailed discussion of this issue).

Other transmission projects built through extensive wetlands have encountered cost overruns. Cost overruns on the Central Upper Peninsula Transmission Project (Commission docket 6630-CE-245), constructed between December 1997 and the spring of 2000, attributed to wetland construction clearing during mild winters were approximately $83,000 per mile in 1998 dollars. Using a 3 percent inflation rate would result in approximately $88,000 in 2000 dollars. The applicants add a $3.2 million "wetlands accessibility factor" for each of the Oliver route that should adequately cover the additional cost of building through 15 to 19 miles of wetlands on those routes. However, no such contingency dollars are included for the Tripoli and Owen routes and those routes include anywhere from 19.5 to 27.0 miles of wetland crossing. This would add from $1.7 to $2.4 million to the cost of those routes.

Easement acquisition is another area where costs could exceed those estimated by the applicants. The cost estimates in the application are based on $4,500 per acre (easement, appraisals, and acquisition costs). This may be an underestimate, depending on the need for condemnation of private lands and other acquisition costs. If, for example, this cost were to increase to $6,000 per acre, it would add approximately $2 million dollars to the cost of each route or about one percent to the overall project cost.

Table 6-17 Project Costs

Route	Line Design	Length (miles)	Cost	Cost Per Mile	With 345kV Underground	Cost With 5 Percent Fee
Oliver 1	Double circuit	93.5	$58,197,000	$622,428	$64,197,000	$67,406,850
	Parallel circuit	93.5	$50,419,000	$539,241	$56,419,000	$59,239,950
Oliver 2	Double circuit	99.2	$55,736,000	$561,855	$61,736,000	$64,822,800
	Parallel circuit	99.2	$54,455,000	$548,942	$60,455,000	$63,477,750
Oliver 3	Double circuit	92.8	$65,215,000	$657,409	$71,215,000	$74,775,750
Tripoli 1*	Double circuit	130.6	$79,993,000	$589,995		$80,825,000
Tripoli 2*	Double circuit -	137.6	$80,806,000	$631,297		$84,846,300
Tripoli 3*	Double circuit	129.5	$77,105,000	$560,356		$80,960,250
Tripoli 4*	SC, H-frame	131.9	$69,134,000	$524,140		$72,590,700 .
	SC, Single Pole	131.9	$71,477,301	541,905		$75,051,000
Owen 1*	Double circuit	121.8	$67,679,000	$555,657		$71,062,950
*	Parallel circuit	121.7	$61,645,000	$506,117		$64,727,250
Owen 2*	Double circuit	116.4	$58,550,000	$503,007		$61,477,500
Owen 3*	Double circuit	114.9	$60,193,000	$517,122		$63,202,650
Owen 4*	SC H-frame	119.0	$61,297,000	$515,101		$64,362,000 .
	SC Single Pole	119.0	$61,846,000	$519,714		$64,938,000 .

*Segment 310 must be added if segments 311 or 312 are used (2.6 miles, $951,675)

Column 6 adds $6 million to total route costs for placing only the 345 kV circuit underground at the Namekagon River crossing. This figure does not include the cost of placing the existing 161 kV line under the river.

Methods of Analysis

Fieldwork methods

The Arrowhead-Weston project is different than any other project reviewed in the past, both in its scope (voltage, length, and number of possible line designs) and complexity. Also, the number of people and variety of resources affected are greater than for previous projects reviewed by the Commission. Because of these problems, it has been necessary to approach the analysis of this project somewhat differently than for previous projects. The change in approach affects several aspects of the EIS process.

A large number of Commission staff are assigned to the project. It would not have been practical to have one person become familiar with and complete an environmental analysis of all 1,000 miles of proposed routes. The project was divided into four areas and an environmental analyst was assigned to each area. The Commission also hired an environmental consultant to complete the environmental review of the Rhinelander-area support project for the draft EIS.

In doing fieldwork for this EIS, Commission staff relied on a wide number of resources. It developed close contacts with a number of state and federal agencies that have interests in various parts of the project area. The reasons for this are twofold: (1) the size of the project requires a more systematic approach in acquiring information and data about the project area and (2) the relative inaccessibility of some portions of this project requires reliance on other agency field staff for input on the quality of some remote resources. Commission staff has worked more formally with DNR staff on this project. The DNR has provided information on many of the state-owned wildlife, fishery, and special use areas. It also helped to develop GIS data on endangered species locations, quality wetlands and areas identified as under consideration for protection by the state.

Commission staff has also worked very closely with county foresters. The county forest plans provided information about natural resources and developed recreational uses that might be affected by the proposed line. The forest offices were very generous with their time and materials when requested.

Commission staff contacted municipal government offices to find out about restricted zoning or land use categories that would be affected by the proposed project. Environmental analysts working on the project also contacted individual landowners who provided specific information about special resources on their property.

Although Commission staff always works with the DATCP on major transmission line projects, the relationship was intensified on this project. Information useful in the EIS and the AIS was shared and a concerted effort was made to use the most up-do-date resources and information when covering issues such as stray voltage, induced currents, and EMF.

Commission staff worked closely with several federal agencies as well. The NPS, the National Trails coordinator, and the COE all have an interest in this project and would have permit applications to review if the Commission approves the project. Commission staff kept these agencies informed as the EIS has been developed and used their knowledge where appropriate. For example, several national trails would be affected by the project. Detailed maps and current information on development or use of each trail are important. The proposed Namekagon River crossings would be located within the St. Croix National Scenic Riverway. Joint field visits to the proposed crossings were conducted with local NPS staff and discussions about river crossing technology options were expanded beyond those proposed in the application.

All contacts with federal state and county agencies were for the purpose of gathering accurate information. None of the agencies expressed an opinion about the need for the proposed line or the location of the line. Their cooperation should not be taken as support for the proposed line or for any particular route. They may comment on the EIS and participate in the remainder of the Commission review process as they see fit.

Commission staff has made an effort to use information and resources provided by landowners. Some of the information was gathered at the initial information meetings held before the application was filed. Commission staff also attended forums and meetings organized locally, reviewed all written comments (letters, postcards, and e-mail), and checked out tips/complaints/new information by phone and in the field.

Commission staff has not walked every mile of the proposed routes; that is rarely done even for shorter projects. It is not possible because of the need to secure landowner permission and it is not always necessary. For an ordinary transmission line project, the areas that are not accessible on foot are often visible from a nearby road or an existing ROW. Sometimes it is possible to get a general sense of the quality of a resource by making a short entrance into a wetland or woodlot, especially if it is of limited size.

That is not the case with large portions of this project. There are many remote areas traversed by the proposed routes. To facilitate finding the areas that Commission staff considers critical to see or know more about, it has used a variety of maps (topographical, plat, zoning,) aerial photos, and verbal and written information from agencies and the public. Commission staff also created and used many GIS maps (e.g. wetlands, forests, rivers, wolf territories, and transportation grids) in developing the EIS.

Commission environmental and engineering staff flew the proposed routes in a helicopter prior to the submittal of the final application. This provided a good overview of the project area and allowed Commission staff to visually check out several potential problem areas and areas difficult to access on the ground. Commission staff members have also walked, canoed, bicycled and skied into some of these more remote areas.

Anyone affected by the proposed project who believes that Commission staff has omitted important information from the final EIS or inadequately described the impacts on some special or significant resources or issues may testify at the hearings that will be held after the final EIS is issued.

Forest fragmentation methods

The approach used for analysis of the forest fragmentation issue for this EIS was more rigorous than has been possible in the past. GIS data and recently acquired technology enable Commission staff to analyze this issue in greater detail.

Segment types were ranked by their potential for fragmentation impact.

Most Potential - New ROW, no existing infrastructure.

Some Potential - Substantially expanding an existing ROW (parallel transmission line construction or adding a transmission line to an existing pipeline or rail corridor) could increase the existing fragmentation of a forest block, primarily in the form of edge effects.

Least Potential – Using existing transmission line ROW with double circuit construction.

For each route segment specific areas were identified where the potential to create or increase forest fragmentation exists. An important determination is the minimum size for candidate blocks of unbroken forest habitat. The "minimum" size will vary depending on the area of the country, habitat types, and species considered. Some species are very sensitive to fragmentation, others are not sensitive at all, while many others are somewhere in between. This species variability in sensitivity to fragmentation often manifests itself in significant variation in the size of forest blocks required to sustain populations (see Chapter 5 – Forest Resources/Forest Fragmentation). For example, studies have shown that Midwestern forests of about 1,000 acres in size have a 95 percent probability of supporting moderately sensitive and a 67 percent probability of supporting sensitive bird species. Reducing the size of forest blocks to 200 acres decreases the probability of supporting moderately sensitive and sensitive species to about 75 percent and 30 percent, respectively. [183] Because the number of sensitive and moderately sensitive species decreases gradually as forest size decreases, it is impossible to pick one size for forest blocks included in fragmentation analysis. For practical purposes this analysis reviewed contiguous forest blocks 200 or more acres in size.

Focusing solely on size is problematic, because the forest composition and shape of the block also affect sensitivity to fragmentation. The natural landscape in the areas of concern is mostly a complex mix of upland and lowland forests and wetlands. In order to qualify as a site where forest fragmentation would occur, an area would also need to have a high percentage of upland and wetland forest cover with a minimum of interspersed non-forested wetlands. Most of the forest blocks identified in this analysis had very high percentages of forest cover (>75 percent.) After identifying the candidate forest blocks equal to or greater than 200 acres that would be affected by new or expanded ROW, the blocks were sorted by route and size. This allowed for a comparison of fragmentation potential between routes.

A general description of forest fragmentation impacts is found in Chapter 5 and route-specific effects related to fragmentation are found in Chapters 7, 9, and 11.

[183] Herkert, James R. , R. E. Scafoni, V. M. Kleen, and J. E. Schwegman. 1993. Habitat Establishment, Enhancement and Management for Forest and Grassland Birds in Illinois. Division of Natural Heritage, Illinois Department of Conservation, Natural Heritage Technical Publication #1. Springfield Illinois. Northern Prairie Wildlife Research Center Home Page. http:/www.npwrc.usgs.gov/resource/othrdata/manbook/manbook.htm (version 16Jul97).

Estimated Magnetic and Electric Fields and Noise

Magnetic fields

The following tables show the calculated magnetic field levels for the various line designs proposed for the 345 kV Arrowhead-Weston Transmission Project. As described in Chapter 5 and in Appendix D, magnetic field levels are affected by several factors. These factors include: the configuration of the conductors (based on structure type); the construction design (whether a line is double circuit, single circuit, or built parallel to another transmission line); and the current (amperage) carried on a line. Many line and construction designs have been proposed for different parts of this project. If this project is approved, the final decision would likely limit or direct the applicants regarding the structure types and construction designs to be used.

The current (amperage) on the proposed 345 kV line would vary, depending on whether the line connects to a new 345/115 kV substation (near Tripoli) or whether it continues all the way from the Arrowhead Substation in Minnesota to the Weston Substation near Wausau without interruption.

The tables below are divided into sections that reflect the expected amperage (A) and the various line and construction designs proposed. All values are estimated magnetic field levels in 2011 at normal load (80 percent of peak load.) The first set of tables would apply to all of the routes in the Owen Sectors and also to the routes in the Oliver Sector, if the new Tripoli Substation were not approved.

Table 6-18 **Oliver - Owen - Weston (approx. 780 A)**
Calculated magnetic fields (mG) for proposed single circuit 345 kV transmission line designs

	Distance to Proposed Centerline								
	-300'	**-200'**	**-100'**	**-50'**	**0'**	**50'**	**100'**	**200'**	**300'**
Single pole	2.0	4.7	18.4	58.4	121.1	46.2	16.6	4.8	2.2
H-frame	2.6	5.9	23.9	86.5	192.9	87.2	24.4	6.2	2.8

Table 6-19 **Oliver - Owen - Weston (approx. 780 A)**
Calculated magnetic fields (mG) for proposed single pole double circuit 345 kV with various voltage lines

	Distance to Proposed Centerline								
	-300'	-200'	-100'	-50'	0'	50'	100'	200'	300'
345/345 kV	1.5	3.6	14.3	44.0	106.9	34.1	9.6	2.4	1.1
345/161 kV	2.1	4.9	19.2	56.4	92.9	23.2	9.1	3.1	1.5
345/115 kV	1.8	4.3	17.5	53.7	93.0	22.4	7.2	2.3	1.2
345/69 kV	2.2	5.1	19.8	57.9	93.3	25.5	10.1	3.4.	1.7

Table 6-20 **Oliver Owen -Weston (approx 780 A)**
Calculated magnetic fields (mG) for proposed single circuit, single pole or H-frame 345 kV line parallel to an existing transmission line

	Distance to Proposed Centerline								
	-300'	-200'	-100'	-50'	0'	50'	100'	200'	300'
345 single pole parallel to:									
161 kV H-frame	2.8	6.9	35.8	106.1	79.4	22.4	13.5	3.9	1.9
115 kV H-frame	2.7	6.8	35.5	106.3	84.0	45.2	14.0	3.9	1.9
69 kV H-frame	2.8	7.0	36.0	107.1	79.0	12.9	10.6	3.5	1.7
345 single pole parallel to:									
345 kV H-frame	3.8	9.1	42.8	100.7	68.9	127.0	52.1	8.6	3.5
115 kV single pole davit arm	3.2	7.4	33.8	96.9	65.8	55.5	20.1	5.1	2.3
345 H-frame parallel to:									
161 kV H-frame	3.9	10.4	74.7	188.3	94.2	32.5	19.5	5.2	2.5
115 kV H-frame	4.0	10.5	74.9	187.4	95.1	55.3	21.8	5.5	2.6
69 kV H-frame	3.8	10.2	74.4	189.2	97.9	20.8	15.4	4.6	2.3
345 H-frame parallel to:									
345 kV H-frame	4.8	12.4	88.5	184.5	66.9	117.0	67.5	11.2	4.6
115 kV single pole davit arm	3.5	9.4	63.4	189.4	104.5	67.6	21.3	5.1	2.4

The estimated magnetic field levels in the following tables would be applicable only if the new Tripoli Substation were approved. These values would apply to all routes in the Oliver Sector and the portion of the routes in the Tripoli Sector between Exeland and the new Tripoli 345/115 kV substation.

Table 6-21 Oliver - Tripoli (approx. 808 A)
Calculated magnetic fields (mG) for proposed single circuit 345 kV transmission line designs

	Distance to Proposed Centerline								
	-300'	**-200'**	**-100'**	**-50'**	**0'**	**50'**	**100'**	**200'**	**300'**
Single pole davit arm	2.1	4.8	19.0	60.2	124.8	47.6	17.1	4.9	2.3
H-frame	2.9	6.4	25.1	89.9	198.8	89.1	24.6	6.1	2.7

Table 6-22 Oliver - Tripoli (approx. 808 A)
Calculated magnetic fields (mG) for proposed single pole double circuit 345 kV with various voltage lines

	Distance to Proposed Centerline								
	-300'	**-200'**	**-100'**	**-50'**	**0'**	**50'**	**100'**	**200'**	**300'**
345 kV with 161 kV	2.2	5.1	20.0	58.9	95.9	24.5	9.7	3.3	1.6
345 kV with 115 kV	1.9	4.5	18.3	55.9	95.9	23.4	7.7	2.5	1.3
345 kV with 69 kV	2.3	5.3	20.6	60.1	96.4	26.8	10.7	3.6	1.7

Table 6-23 Oliver - Tripoli (approx. 808 A)
Calculated magnetic fields (mG) for proposed single circuit, single pole or H-frame 345 kV line parallel to an existing transmission line

	Distance to Proposed Centerline								
	-300'	**-200'**	**-100'**	**-50'**	**0'**	**50'**	**100'**	**200'**	**300'**
345 kV single pole parallel to:									
161 kV H-frame	2.9	7.1	36.9	109.5	81.8	20.5	13.4	4.0	1.9
115 kV H-frame	2.8	7.0	36.6	109.7	86.3	43.2	14.0	4.0	1.9
69 kV H-frame	2.9	7.2	37.1	110.4	81.4	13.2	10.7	3.6	1.8
345 kV H-frame parallel to:									
161 kV H-frame	4.0	10.7	77.0	194.2	97.7	30.9	19.4	5.2	2.5
115 kV H-frame	4.1	10.8	77.2	193.3	98.4	53.2	21.9	5.5	2.6
69 kV H-frame	3.9	10.5	76.6	195.1	101.2	21.0	15.5	4.7	2.3

The estimated magnetic field levels in the tables below would be applicable only if the new Tripoli Substation were approved. These values would apply to the portions of the routes in the Tripoli Sector between the new Tripoli Substation and the Weston Substation south of Wausau.

Table 6-24 **Tripoli - Weston (approx. 628 A)**
Calculated magnetic fields (mG) for proposed single circuit 345 kV transmission line designs

	Distance to Proposed Centerline								
	-300'	**-200'**	**-100'**	**-50'**	**0'**	**50'**	**100'**	**200'**	**300'**
Single pole	1.7	3.7	12.9	36.2	95.8	46.4	14.7	3.8	1.7
H-frame	2.1	4.7	19.1	69.2	154.7	69.7	19.4	4.9	2.2

Table 6-25 **Tripoli - Weston (approx. 628 A)**
Calculated magnetic fields (mG) for proposed single pole double circuit 345 kV (628A) with various voltage lines

	Distance to Proposed Centerline								
	-300'	**-200'**	**-100'**	**-50'**	**0'**	**50'**	**100'**	**200'**	**300'**
345 / 345 kV	0.9	2.1	9.4	32.3	91.7	27.4	6.6	1.2	0.5
345 /115 kV	2.3	5.4	20.6	58.5	91.8	27.6	11.7	3.8	1.8

Table 6-26 **Tripoli - Weston (approx. 628 A)**
Calculated magnetic fields (mG) for proposed single circuit, single pole or H-frame 345 kV line parallel to an existing transmission line

	Distance to Proposed Centerline								
	-300'	**-200'**	**-100'**	**-50'**	**0'**	**50'**	**100'**	**200'**	**300'**
345 kV single pole parallel to:									
345 kV H-frame	2.2	5.8	32.5	103.5	102.2	135.0	52.2	6.9	2.6
115 kV davit arm	1.2	3.2	23.7	107.5	131.5	108.1	21.9	3.8	1.4
345 kV H-frame parallel to:									
345 kV H-frame	2.0	6.4	64.8	162.0	118.2	144.1	53.4	4.3	1.1
115 kV davit arm	2.5	6.3	41.0	114.6	84.8	72.4	21.0	4.2	1.8

Table 6-27 **Tripoli -Weston (approx. 628 A)**
Calculated magnetic fields (mG) for other proposed line designs

	Distance to Proposed Centerline								
	-300'	**-200'**	**-100'**	**-50'**	**0'**	**50'**	**100'**	**200'**	**300'**
345/345 kV dbl cir single pole parallel to 46 kV wishbone	1.1	3.2	21.0	83.8	45.8	19.4	4.5	1.0	0.4
46 kV horizontal line post	0.1	0.2	1.0	3.4	15.2	3.3	1.0	0.3	0.2

The Tripoli to Rhinelander 115 kV transmission line, like any other device that is energized by electricity, would produce electric and magnetic fields. A detailed discussion of EMF and related health concerns can be found in Appendix D. Table 6-28 shows the calculated magnetic fields for the proposed 115 kV transmission line designs.

Table 6-28 Tripoli - Highway 8 (approx. 484 A)
Calculated magnetic fields (mG) for proposed 115 kV transmission line designs

	Distance to Proposed Centerline								
	-300'	**-200'**	**-100'**	**-50'**	**0'**	**50'**	**100'**	**200'**	**300'**
Single circuit davit arm	0.7	1.6	6.4	22.3	87.8	21.4	6.6	1.8	0.8
Double circuit davit arm	0.7	1.7	6.6	22.3	63.6	13.4	4.7	1.4	0.6
Single circuit davit arm(parallel to existing H-frame)	0.6	1.3	4.5	13.8	68.4	41.6	9.8	2.2	1.0
Single circuit HLP w/ 24.9 kV distribution	0.8	1.4	4.3	11.9	30.6	11.6	4.4	1.5	0.9

Electric fields

The following tables show the calculated electric fields for the proposed 345 kV Arrowhead-Weston Transmission Project. Electric fields are directly related to the voltage of the line. The values shown, in kilovolts per meter (kV/m), are based on normal load conditions and a bottom conductor height of 30.0 feet above the ground.

Table 6-29 Calculated electric fields (kV/m) for proposed single circuit 345 kV transmission line designs

	Distance to Proposed Centerline								
	-300'	**-200'**	**-100'**	**-50'**	**0'**	**50'**	**100'**	**200'**	**300'**
Single pole davit arm	.04	0.1	0.5	2.2	2.6	2.1	0.6	0.1	.04
H-frame	.03	.09	0.7	4.0	4.1	4.0	0.7	.09	.03

Table 6-30 Calculated electric fields (kV/m) for proposed single pole double circuit 345 kV line with various voltage lines

	Distance to Proposed Centerline								
	-300'	**-200'**	**-100'**	**-50'**	**0'**	**50'**	**100'**	**200'**	**300'**
345 kV with 345 kV	0.1	0.2	0.3	1.5	8.3	1.5	0.3	.2	0.1
345 kV with 161 kV	.04	0.1	0.2	1.4	3.5	0.4	0.1	.03	.02
345 kV with 115 kV	.05	0.1	0.2	1.4	3.8	0.2	0.1	.04	.02
345 kV with 69 kV	.05	0.1	0.2	1.4	4.0	.09	0.1	.06	.03

Table 6-31 Calculated electric fields (kV/m) for proposed single circuit, single pole or H-frame 345 kV line parallel to an existing transmission line

	Distance to Proposed Centerline								
	-300'	-200'	-100'	-50'	0'	50'	100'	200'	300'
345 kV single pole parallel to:									
345 kV H-frame	.06	0.2	1.8	2.5	6.6	3.7	3.4	0.3	.08
161 kV H-frame	.06	0.2	1.6	2.4	2.9	1.5	0.4	.04	.02
115 kV H-frame	.06	0.2	1.6	2.7	3.1	1.3	0.4	.08	.03
115 kV davit arm	.06	0.2	1.4	2.9	3.5	1.6	0.4	0.8	0.4
69 kV H-frame	.06	0.2	1.6	2.5	3.1	0.5	0.1	.05	.03
345 kV H-frame parallel to:									
345 kV H-frame	.05	0.2	4.0	4.1	7.3	4.0	4.0	0.2	.05
161 kV H-frame	.05	0.2	3.4	4.0	4.0	1.3	0.6	.06	.02
115 kV H-frame	.05	0.2	3.4	4.0	4.2	1.0	0.4	.05	.02
115 kV davit arm	.05	0.2	2.8	4.0	5.0	1.8	0.3	.03	.01
69 kV H-frame	.05	0.2	3.4	4.0	4.4	0.6	0.3	.04	.02

Table 6-32 Calculated electric fields (kV/m) for other proposed transmission line designs

	Distance to Proposed Centerline								
	-300'	-200'	-100'	-50'	0'	50'	100'	200'	300'
345/345 kV dbl cir single pole parallel to 46 kV wishbone	0.1	0.2	0.5	7.7	3.7	0.4	0.3	0.1	0.1
46 kV horizontal line pole	.002	.005	.02	.05	0.4	.05	.02	.004	.002

Table 6-30 describes electric fields associated with the proposed 115 kV Tripoli to Rhinelander transmission line designs at normal load conditions.

Table 6-33 Calculated electric fields (kV/m) for proposed 115 kV transmission line designs

	Distance to Proposed Centerline								
	-300'	-200'	-100'	-50'	0'	50'	100'	200'	300'
Single circuit davit arm	.002	.006	.02	.08	0.8	.08	.02	.005	.002
Double circuit davit arm	.002	.006	.02	.08	0.8	.08	0.2	.005	.002
Single circuit davit arm (parallel to existing H-frame)	.001	.02	0.2	1.0	2.2	0.8	0.2	.02	.009
Single circuit HLP W/24.9 kV distribution	.008	.02	.07	0.2	0.3	0.2	.07	.02	..008

Noise

Noise can be defined as sound that is loud, unpleasant, unexpected, or undesired. Noise from transmission lines usually takes four forms: a sizzle, crackle, or hiss and a low frequency hum.

The sizzle, crackle, or hiss noises are caused by a phenomenon known as "corona" and occur most often during periods of high relative humidity or rain. The humming noise most often is noticeable on older lines, and is usually the result of conductor mounting hardware that has loosened very slightly over the years.

Sound is measured in units called decibels, which are abbreviated dB. Sound measurements are typically frequency-weighted to simulate the range of frequencies audible to people with normal hearing. The A-weighted curve, abbreviated dBA, is usually used to measure everyday sounds such as traffic noise and other ambient noise. In addition, sound level measurements may be time-weighted, in order to reduce effects of transient noises such as aircraft. Time-weighted noise measurements are typically designated using an L along with the time weighting criteria. For instance, L5 sound measurements reported in dBA indicate a sound level that is exceeded 5 percent of the time using the A-weighted frequency curve.

Noise levels of approximately 50 dBA are typical in a quiet urban area during daylight hours; normal conversation is about 60 dBA.

In the application, the applicants include calculated audible noise data for several possible single- and double circuit line configurations. The maximum calculated L5 noise level, 56 dBA, occurred during rain conditions for a parallel line configuration including a 345 kV line and a second 69 kV transmission line. The calculated noise levels do not include estimates of existing ambient noise.

The application also includes actual noise measurements taken near similar existing 345 kV lines. The maximum noise level measured was 52 dBA, and includes ambient noises such as wildlife.

The resulting sound level when two sound sources are combined is not the sum of the two sound levels. The predicted sound level must be calculated using unweighted sound pressure levels, and are based on the difference between the two sound pressure levels being combined. For instance, the combined level of two noise sources of 66 dB and 70 dB is about 71.45 dB.[184]

Noise level measurements taken by WEPCO (Commission docket 6630-CE-256) near 345 kV transmission lines similar to those proposed for this project ranged from 37.5 dBA to 51.1 dBA. The noise level measurements include both transmission line noise and ambient noise from sources such as vehicle traffic and wildlife. Noise level measurements taken at varying distances from the line, together with observations of the character of audible noise present during each measurement, suggest that the transmission line noise does not "carry" over long distances. The transmission line noise was typically either inaudible or barely audible at a distance of 200 feet from the centerline of the line.

WEPCO also investigated the use of bundled conductors similar to those proposed in this project to reduce transmission line noise on a 35-mile long, 230 to 345 kV reconductoring

[184] T. G. Beckwith, and N. Lewis Buck. 1973. Mechanical Measurements. 17:560.

project. For the predicted current flows and line configuration, the company found that use of the bundled conductors would slightly decrease noise levels but would also slightly increase electrical losses and EMF levels. Use of bundled conductor also would have increased the cost of that 35-mile reconductoring project by $7.5 million.

Fiber Optics and Regeneration Stations

The application indicates that one of the shield wires for the 345 kV transmission line would contain a fiber optic communication line that would be used, in part, to control and monitor power flows along the transmission line. The applicants anticipate utilizing a 48-fiber optical ground wire, and OC-3[185] terminal equipment at the Arrowhead Substation and the Weston Substation. The OC-3 terminal equipment would provide a 155-megabit per second transmission bandwidth, or the equivalent of 2,016 voice conversations, per fiber. Upgrading the terminal equipment would provide significant additional capacity over the same 48-fiber optical ground wire.[186]

The fiber optic system would require a signal regeneration station every 50 to 60 miles. The applicants anticipate the need for four regeneration stations. Each regeneration station would consist of a 16 by 26 foot metal building, within an enclosed yard, and would be located next to an existing substation or within the 345 kV power line ROW. Each regeneration station requires a source of 120-volt electrical service, and a driveway with access to a maintained roadway. The regeneration stations could provide points for additional fiber optic interconnections. However, additional fiber optic interconnections would require additional facilities and terminal equipment at each regeneration station.

The applicants indicate that a minimum of eight fibers, plus four additional spare fibers for backup, would be reserved solely for operation of the transmission facilities. Currently, the applicants indicate that there are no plans for the use of the remaining 36 fibers within the proposed optical ground wire. However, they indicate that fibers not reserved for electric utility purposes would be available to expand a fiber-optic network in Wisconsin.

---

[185] The letters OC in the reference to OC-3 equipment stand for words Optical Carrier.

[186] The electronics on controlling each fiber define what capacity (bandwidth) the fiber can provide. The following table lists the standard OC electronics available and the capacity (bandwidth) available. A DS-0 is the base unit of digital transmission capacity used by the telecommunications industry, and each DS-0 is capable of conducing a separate voice conversation.

OC-1	672	28	1	51.84
OC-3	2,016	84	3	155.52
OC-12	8,064	336	12	622.08
OC-48	32,256	1,344	48	2,488.32
OC-192	129,024	5,376	196	9,953.28

Both MP and WPSC have installed fiber optic ground wire as shield wire on sections of their existing electric transmission line networks. In some instances, both MP and WPSC have licensed or leased the fibers not used for control and operations of utility facilities to other parties for communications purposes. Before licensing or leasing any of the proposed fiber-optic system to any of its affiliates, WPSC would have to obtain PSCW approval of an affiliated interest agreement.[187]

Neither WPSC nor MP has been authorized by the Commission to provide telecommunications services in Wisconsin. However, Minnesota Power Telecom, Inc. (MP Telecom), a subsidiary of MP, is a certified alternative telecommunications utility, in Wisconsin. MP Telecom has extended its fiber optic network to the city of Superior, and has publicly announced its intentions to expand service further into Wisconsin.

The PSCW has limited authority over construction of telecommunication facilities. However, since the applicants' proposal to use a fiber optic system is an integral component of the proposed electric transmission line project, the Commission has authority to determine if, or under what conditions, if any, the use of a fiber optic system is in the public interest.

Alternatives to the use of a fiber optic system for control and operation of the electric transmission line include the use of a private fixed operational microwave radio system (microwave radio system), leased telephone circuits, and a dual power line carrier system.

The estimated cost of a microwave radio system, plus the installation of a standard shield wire is approximately $26,150[188] per mile. In comparison, the estimated cost of the proposed fiber-optic ground-wire system is approximately $26,200 per mile. A microwave radio system would likely require the construction of additional towers (ranging in height from 150 to 400 ft, with shorter towers requiring additional sites.) Concerns regarding the use of a microwave radio system include radio frequency interference and other atmospheric anomalies that can cause receiver fading and can increase the chance of reliance on backup systems or service interruptions.

Leased telephone circuits provide another alternative to the proposed fiber optic system. However, leased telephone circuits are subject to availability and limited in bandwidth. In addition, circuit installation, maintenance, testing and restoration are typically outside the control of operating electric utilities. Due to the critical nature of communications circuits for protection, control and operation of the interconnected transmission system, leased circuits are

[187] If MP exercises its right to purchase the portion of the 345 kV transmission line between Ladysmith, Wisconsin and the Minnesota border, and assuming such transaction between WPSC and MP were completed, MP may also need prior Commission approval in order to lease any of the excess capacity of the fiber optic system to any of its affiliates.

[188] The total estimated costs reflects an estimated cost of $21,450 per mile for the microwave radio system, plus an estimated cost of $4,700 per mile for a 3/8" EHS shield wire. The cost estimates for the microwave radio system are based upon information provided by the applicants in response to questions from Commission staff. The cost estimates for the 3/8" EHS shield wire are based on cost estimates provided in Appendix B of the Application.

not a viable primary communications alternative. The cost of a leased telephone circuit would include the recurring lease costs, plus the estimated cost ($4,700 per mile) of a second shield wire.

Another alternative to the fiber optic system would be to utilize a dual power line carrier system.[189]

Environmental impacts

Sites for the fiber optic regeneration stations would be identified if the project is approved and after a route is chosen. The sites would be purchased from willing sellers and would be owned by the applicant, similar to substation sites. Because sites have not yet been chosen, an environmental analysis of the locations is not possible. The information below characterizes some of the environmental impact of these regeneration stations.

There would be at least five sites, with one located at the Weston substation. The applicants prefer the sites be existing substations, on uplands, and near or on an existing road. The sites would be gravel surfaced, fenced, and require a gravel access road. The expected land impact for each site would be 0.25-0.5 acres.

Preferred upland sites would generally avoid lakes, rivers, streams, and wetlands. Located on uplands, the stations may be visible for some distance. Because the applicants have some flexibility in locating the stations it should be possible to find locations where construction would result in little or no incremental environmental impact. Additional clearing of land may be required unless the whole site can be located within the existing ROW. If a new access road would be required, there could also be impacts from the road development.

[189] Applicants propose to use a power line carrier system for the electric transmission line as a backup to the proposed fiber-optic system.